EUROPEAN SYNCHROTRON RADIATION FACILITY

INSTALLATION EUROPEENNE DE RAYONNEMENT SYNCHROTRON

Experiment Report Form

The double page inside this form is to be filled in by all users or groups of users who have had access to beam time for measurements at the ESRF.

Once completed, the report should be submitted electronically to the User Office using the **Electronic Report Submission Application:**

http://193.49.43.2:8080/smis/servlet/UserUtils?start

Reports supporting requests for additional beam time

Reports can now be submitted independently of new proposals – it is necessary simply to indicate the number of the report(s) supporting a new proposal on the proposal form.

The Review Committees reserve the right to reject new proposals from groups who have not reported on the use of beam time allocated previously.

Reports on experiments relating to long term projects

Proposers awarded beam time for a long term project are required to submit an interim report at the end of each year, irrespective of the number of shifts of beam time they have used.

Published papers

All users must give proper credit to ESRF staff members and proper mention to ESRF facilities which were essential for the results described in any ensuing publication. Further, they are obliged to send to the Joint ESRF/ ILL library the complete reference and the abstract of all papers appearing in print, and resulting from the use of the ESRF.

Should you wish to make more general comments on the experiment, please note them on the User Evaluation Form, and send both the Report and the Evaluation Form to the User Office.

Deadlines for submission of Experimental Reports

- 1st March for experiments carried out up until June of the previous year;
- 1st September for experiments carried out up until January of the same year.

Instructions for preparing your Report

- fill in a separate form for each project or series of measurements.
- type your report, in English.
- include the reference number of the proposal to which the report refers.
- make sure that the text, tables and figures fit into the space available.
- if your work is published or is in press, you may prefer to paste in the abstract, and add full reference details. If the abstract is in a language other than English, please include an English translation.

ESRF	**Experiment title:** Aging and dynamics of granular compaction : from grain motion to order propagation	**Experiment number**: ME1080
Beamline: ID19	**Date of experiment**: from: 07 May 2005 to: 09 May 2005	**Date of report**:
Shifts: 6	**Local contact(s)**: Eva PEREIRO LOPEZ	*Received at ESRF:*

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Report:

Using the ID19 beamline of the ESRF we studied grain motion during granular compaction. Granular compaction is the settling behaviour of granular materials when subjected to external excitations, for example tapping (Richard et al., 2005). Compaction is related to both practical and basic scientific problems, as the quest for efficient packing or the investigation of fundamental theories to describe and predict general properties of granular packs.

We observed two types of grain motions. The first one is a diffusive motion relatively small (about one tenth of a grain radius) and the second one is a jump-like motion that is bigger (about a grain radius) but extremley rare. This results are in agreement with numerical simulation and with index matching fluid experiments. This validate the numerical simulation and demonstrate the weak effect of the interstial fluid on the compaction mecanisms. The fact that the motions observed in this work are similar to those obtained in glasses confirm the analogy between the two systems. The next step of this work is to study the memory effects (Josserand 2000) at the scale of the grains. An article on this subject is in preparation.

Preliminary experiments using a peneometer have also been carried out. Cone penetration testing (CPT) is a standard method for evaluation of soil strength for construction purposes, in which a rod with a conical tip is inserted into the ground for

measurement of resistive forces, pore pressure, etc. Classic theories in soil mechanics such as the bearing capacity and cavity expansion theories offer possible mechanisms by which the motion of soil particles exert forces on the penetrometer (Yu & Mitchell 1998; van den Berg 1994). With sufficient number of fitting parameters these theories offer reasonable predictability of soil strength. Microscopic validation of these theories requires, in addition to information obtained by the standard penetrometer, the following:

1)soil material which allows imaging of the interior of the bulk,

2)imaging techniques with sub-particle resolution,

3)computer algorithms to track the motion of individual particles.

Past attempts by others to directly image the soil movement during CPT have been limited to a quasi 3D geometry in which a penetrometer in the shape of a half cylinder, pressed against a glass side window, was lowered into a real soil sample as illustrated in (van den Berg 1994). Since the introduction of transparent soil simulant, new imaging techniques have been tried with much success. For example, vertical cross sections of transparent soil illuminated by a laser sheet have been analyzed by digital image correlation (Sadek et al. 2003). Difficulties in imaging the motion of particles through volume scans, however, have yet to be overcome. Certain anisotropies in the displacement field of particles, for example, can be observed only when one has data from a full volume scan. X-ray tomography is thus a powerful tool. Our preliminray results indicates that rearrangements spread furthest not directly under the penetrometer but in a ring around the penetrometer. In addition, preformed stress chains in the material influence the particle rearrangements.

C. Josserand, A. V. Tkachenko, D. M. Mueth, and H. M. Jaeger Memory Effects in Granular Materials , Phys. Rev. Lett. 85, 3632–3635 (2000)

P. Richard, M. Nicodemi, R. Delannay, P. Ribière et D. Bideau, "Slow relaxation and compaction of granular systems", Nature Materials, 4, 121-128 (2005)

S. Sadek, M. G. Iskander and J. Liu, 2003. Accuracy of digital image correlation for measuring deformations in transparent media. J. Comput. Civil. Eng. 17, 88–96 (2003).

P. Van den Berg, 1994. Analysis of Soil Penetration. Delft University Press (1994).

H. S. Yu, & J.K. Mitchell, Analysis of cone resistance:Review of methods. J. Geotech. Geoenviron. 124, 140–149 (1998).