EUROPEAN SYNCHROTRON RADIATION FACILITY

INSTALLATION EUROPEENNE DE RAYONNEMENT SYNCHROTRON

ESRF

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:** Evolution of the local structure of a granular material during its compaction	**Experiment number**: ME 473
Beamline: ID19	**Date of experiment**: from: 11 September 2002 to: 13 September 2002	**Date of report**:
Shifts: 6	**Local contact(s)**: Xavier THIBAULT	*Received at ESRF:*

Names and affiliations of applicants (* indicates experimentalists):

Patrick Richard*,1 Pierre Philippe*,2 Fabrice Barbe*,3 Stéphane Bourlès*,1 Xavier Thibault*,4 and Daniel Bideau1

1GMCM, UMR CNRS 6626, Université de Rennes I, 35042 Rennes Cedex, France

2PMMH, UMR CNRS 7636, ESPCI, 10 rue Vauquelin, 75231 Paris Cedex 05, France

3LMR, UMR 6138, INSA Rouen, Campus du Madrillet, 76801 Saint-Étienne-du-Rouvray Cedex, France

4ESRF, Boîte Postale 220, F-38043 Grenoble Cedex, France

Report:

The slow dynamics of out-of-equilibrium systems remains a source of debate. Even though granular media are not thermal systems, their relaxation under weak mechanical perturbations have a formal analogy with the slow dynamics of out-of-equilibrium thermal systems. This analogy is based on the idea that the geometry of the system is more important than any other parameter as the type of driving energy or the mechanical interaction between particles. Slow compaction of shaken granular packing - the progressive increase of the packing fraction - appears to provide fundamental information for the investigation of the above analogy. The study presented here used X-ray microtomography to characterise the microstructure of granular packing undergoing compaction.

We used an experimental setup simular to previous ones [1,2]: 200-400 µm diameter glass beads were poured to a height about 80 mm in an 8 mm inner-diameter glass cylinder. This was vertically shaken for a given number N of sinusoidal excitations at a frequency of 70 Hz. Microtomographical analysis at beamline ID19 was then used to reconstruct granular packings (Figure 135). The intensity of the vibration is characterised by Γ, the maximal applied acceleration normalised by gravity. The pixel size is 4.91 µm and the spatial resolution is 10 µm.

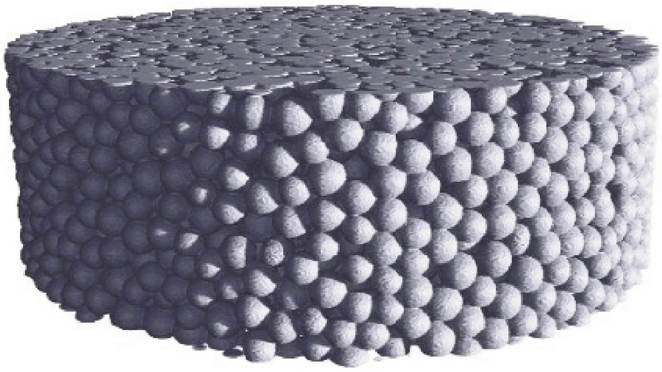

Fig. 1: Part of a reconstructed packing.

By comparison with the small decrease in the average distance between grains accompanying compaction, evidence of a transformation in the packing microstructure appears to be better described by the size of the interstitial voids. Following previous work [3] we defined a pore size via the Voronoi tessellation and normalised it by the mean volume of a grain <w>. Figure 136 presents the evolution of the pore volume distribution for Γ= 3.0 at different stages of the compaction. An exponential decay law is found for the distribution of the voids, at least for the pores larger than octahedral pores. The exponential shape persists during the compaction of the packing yet with a reduction of the tail. These results were found to be very close to results of numerical simulations [3] where there were only geometric constraints in a packing of identical hard spheres. This agreement emphasises the fundamental importance of the steric constraint between the grains that rules the local rearrangements of grains allowed by the shaking energy.

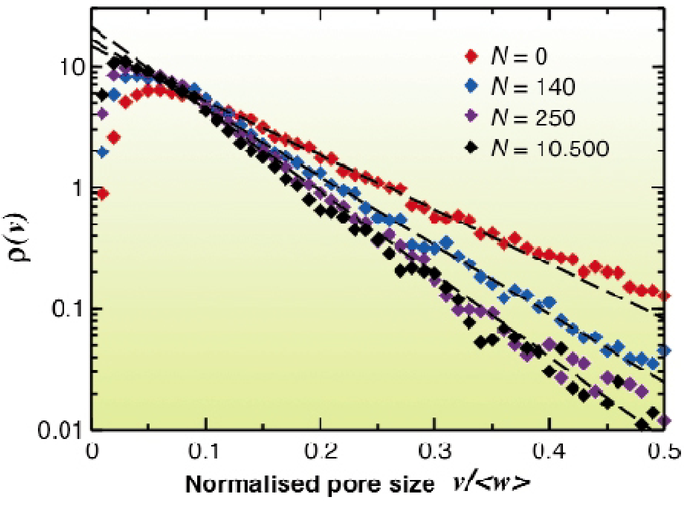

Fig. 2: Evolution of the volume distribution of the pores for Γ= 3.0 at different stages of the compaction.

This study should be completed by considering individual grain motion at each degree of excitation in order to tackle the problem of diffusivity in granular media.References

[1] B. Knight, C.G. Fandrich, C.N. Lau, H.M. Jaeger, and S.R. Nagel, Phys. Rev. E 51, 3957, (1995).

[2] P. Philippe and D. Bideau, Europhys. Lett. 60, 677 (2002).

[3] P. Philippe and D. Bideau, Phys. Rev. E 63, 051304 (2001).