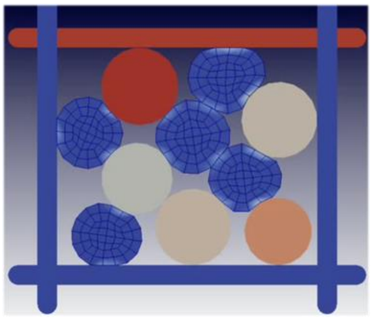
DEM Modelling Seminars: 1.30pm Friday 1 March 2019 in ES203 and 2.00pm Monday 4 March 2019 in ES209, ES Building, Callaghan Campus

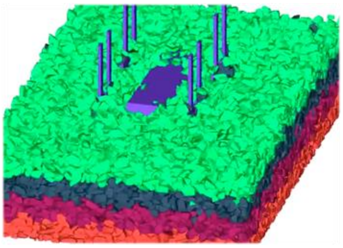
Granular modelling of environmental processes: from particle scale prediction to design of smart granular structures.

The University of Newcastle will welcome **Dr Emilien Azema, Associate Professor at the University of Montpellier,** as a visitor in March 2019. Emilien is researcher in computational mechanics, with interest in the investigation of the rheology and microstructure of granular materials using Discrete Element Method (DEM) and Contact Dynamics (CD) approach.



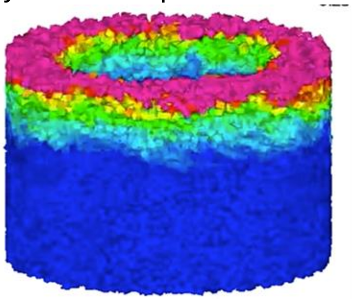
DEM-FEM Interaction

Two presentations/discussions have been organised during Emilien’s short stay. They will be held at 1.30pm Friday 1 March in ES203 and at 2.00pm Monday 4 March in ES209, ES Building, Callaghan Campus. Friday’s presentation is titled: *Granular modelling of environmental processes: from particle scale prediction to design of smart granular structures.*



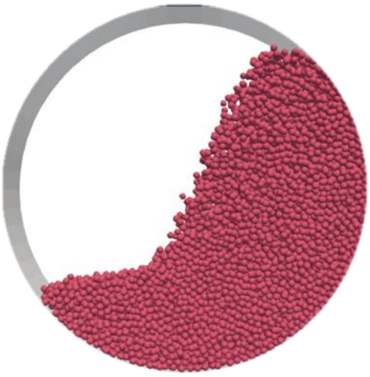
Dynamic compaction

For planning purposes, it will be greatly appreciated if you can respond to this message (email Kirstin.Dunncliff@newcastle.edu.au) indicating your interest in participating and your specific topics of research or interest to customise Monday’s presentation to the audience if possible.

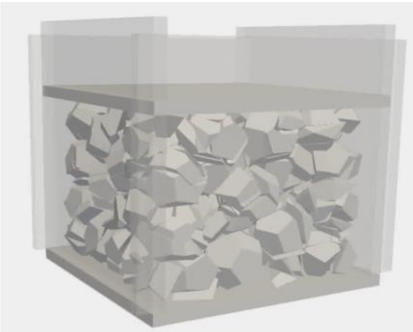


Hollow cylinder

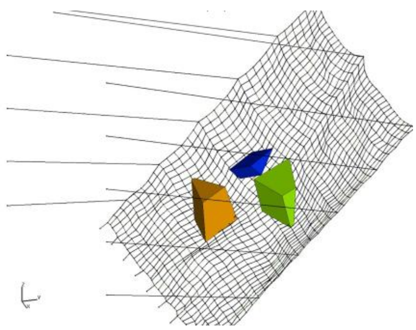
Emilien is a mathematician by background and has almost 15 years of experience working in granular mechanics and DEM modelling developing and using the open source code LMGC90. His publications and book chapters have had a profound impact on this very specialised community, reaching more than 1300 citations. Emilien is an active editorial reviewer and collaborator at the national and international level. Since 2015, Emilien has collaborated with the University of Newcastle, researching issues associated with the scaling of natural granular materials. As a result of this collaboration, several papers have been produced, some already published.



3D Mill rheology



Particle crushing



Rock-fall

Granular matter is ubiquitous in nature and industry. Dry sand in deserts, rocks and snow in mountains, sediments in riverbeds, ores, powders to rubbles piles asteroids, or most construction materials, belong to the large family of granular materials. In this sense, granular matter has never really been an independent disciplinary field and has for many years mobilised an important research effort in diverse disciplines such as soil mechanics, geology, process engineering, physics of condensed matter and very recently astrodynamics and planetary science. All these communities benefit today from a rich experimental background and various continuums and discrete models, often associated with Finite-Element or Discrete Element calculations.

Discrete Element Method (DEM), developed since three decades for grain-scale numerical modelling of granular materials, has become a mature methodology for bridging between the scales involved in the complex spatial-temporal phenomena observed in plastic granular flows.

By providing access to the local physical mechanisms, discrete modelling assists with the definition of constitutive material properties for a wide range of grain properties, inter-particle interactions and complex loading histories. It should be noted that the macro and microstructural properties in a granular medium have mostly been studied in the case of isometric particles (disks/spheres). In practice, whether from an experimental point of view or discrete numerical methods, spherical or circular particles are easy to manipulate and the link with physical analysis is straightforward. Thanks to the increasing power of computers and experimental techniques, there is now a large field of possible investigation, still almost virgin, on the behaviour of granular materials having a realistic (i.e. complex) composition.

Indeed, very recently, following a dramatic degradation of natural resources and a rapid development of urbanization, new challenges in sustainable development have led the communities to consider a breakthrough approach based on a fundamental understanding of primary mechanisms at the natural scale of grains and their interactions in the perspective of optimizing performances. Several well-known examples are elongated and platy shapes (occurring in bio-materials and pharmaceutical applications), angular and facetted shapes (in geo-materials). Sintered powders such as UO_2 pellets used as nuclear fuel where the particles are solid nonconvex aggregates. A general feature is that rounded particles enhance flow-ability whereas angular shape is susceptible to improve shear strength, a factor of vital importance to civil-engineering applications. Along with the shape of the grains, an important aspect is the grain size distribution. These two constitutive characteristics are a key to the space-filling and strength properties of granular materials and for this reason they need to be optimized in designing particle-based materials such as concrete. More broadly, recycled materials involving mixture of grains of different sizes, shapes or behaviours (e.g. shredded or granulated rubber, crushed glass) are often used into conventional designs and soil improvement projects, and until now very little is known from a scientific point of view on these mixtures.

Numerically, such issues can be addressed with the Contact Dynamic Method that is a class of DEM method, originally developed by J.-J. Moreau and M. Jean in Montpellier, in which particles are assumed to be perfectly rigid and that interact through mutual exclusion and Coulomb friction. This numerical strategy is particularly well adapted to study dense granular materials, or more broadly “Divided Media” under quasi-static to dynamic conditions including a large number of particles, because it does not introduce numerical artefact due to contact stiffness. For this reason, the simulations can be performed with large time steps compared to molecular dynamics (MD) simulations.

Such formalism is implemented in the LMGC90 which is a multipurpose software developed in the LMGC laboratory at the University of Montpellier (France), capable of modelling a collection of deformable or non-deformable particles of various shapes and interactions, in 2D and 3D (https://git-xen.lmgc.univ-montp2.fr/lmgc90/lmgc90_user/wikis/home)

Further information on the Centre can be found at https://www.newcastle.edu.au/research-and-innovation/centre/cgmm/about-us