
Compaction vs. liquefaction of a granular bed under a pressure standing wave forcing

Patrick Mutabaruka^{*1}, Farhang Radjai², Jean-Yves Delenne³, Alfredo Taboada⁴, and Frédéric Bouchette⁵

¹Institut Français de Recherche pour l'Exploitation de la Mer (IFREMER) – Institut Français de Recherche pour l'Exploitation de la Mer (IFREMER), Institut Français de Recherche pour l'Exploitation de la MER - IFREMER – France

²Laboratoire de Mécanique et Génie Civil (LMGC) – Laboratoire de Mécanique et Génie Civil (LMGC), Université de Montpellier, CNRS, 34090 Montpellier, France – CC 048 Place Eugène Bataillon, 34095 MONTPELLIER CEDEX 5, France

³Ingénierie des Agro-polymères et Technologies Émergentes (UMR IATE) – INRAE – Campus de la Gaillarde 2, place Pierre Viala 34 060 Montpellier Cédex 02 - FRANCE, France

⁴GEOSCIENCES-Montpellier, CNRS, University of Montpellier – Université Montpellier II - Sciences et techniques – France

⁵GEOSCIENCES-Montpellier, CNRS, University of Montpellier, Montpellier – Université Montpellier II - Sciences et techniques – France

Résumé

Three dimensional coupled DEM-LBM approach is utilized to investigate the internal signature of ‘compaction’ state versus ‘liquefaction-like’ state of a granular bed composed of spherical particles fully immersed in a fluid while being subjected to a pressure standing wave. A wide parametric space covering large range of packing fraction, pressure wave properties (frequency and magnitude) and relative density were explored and a very promising but ‘non-trivial’ insight results were obtained. Two granular beds were used: a frozen bed to focusing on the pressure wave changes in the bed and, a free bed to investigate, at short and long term, the microstructure of the granular bed changes that should enable to identify whether we are in a ‘compaction’ or in a ‘liquefaction-like’ state. For the fluid point of view in the granular bed regarding the forcing signal, the pressure wave attenuation in the granular bed shows a strong dependency on the packing fraction while the forcing frequency plays a role in the phase shift. Non effect on the attenuation in the pressure wave magnitude were observed. The microstructure changes at long term on the free bed shows that the ‘liquefaction-like’ state is more favorable of lower-pressure wave magnitude combined in certain measure with lower particles relative density: this corresponds at the sample level to a lower bed effective stress. The ‘compaction’ state is found to be more favorable of higher-pressure wave magnitude combined in certain measure with higher-particles relative density; contrary to the ‘liquefaction-like’ state, the ‘compaction’ stat correspond to a higher bed effective stress. The analysis of the granular bed contact network revealed that the descriptor of the ‘liquefaction’ versus ‘compaction’ state lies in the variation in its anisotropy while an unclear observed variation in packing fraction, coordination number or effective bed stress should not be used as descriptor key.

*Intervenant