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Computational study of the elastic modulus of mixed pebble beds for WCSB

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Primary concept design of CFETR (Chinese Fusion Engineering Test Reactor) has finished. In the fusion reactor, tritium is bred by mixed pebble bed in CFETR's WCSB (Water Cooled Solid Blanket). In this study, the discrete element method (DEM) was used to study the mechanical behaviors and elastic moduli of mixed pebble beds. The effect of cyclic pressure p within the granular system in different sizes were considered. Besides that, we re-confirmed the nonlinear elastic stress-strain relation, the much lower elastic moduli of a granular system than that of solid materials and the faster growth of moduli than the p1/3 law predicted by the effective medium theory (EMT). We also observed that the cyclic pressure (mechanical excitation) would stiffen the granular system, but this effect would be smaller as the cycle number increases. This indicates that the stability of system could be stronger under this effect. Besides that, the subtle difference in grain sizes was observed to soften the system although it caused a little higher packing density. Furthermore, although the effective moduli of different granular materials Es are diverse, they were found to nearly collapse to the different distribution when both Es and p are non-dimensionalized by particle moduli Ep, and the mixed pebble bed cannot obey the EMT theory.

Eligible for student paper award?

No

Author: Mr LI, Yuanjie (University of Schience and Technology of China)

Co-authors: Mr XIANG, Yang (University of Science and Technology of China); Mr ZHANG, Sheng (University of Science and Technology of China); Mr ZHAO, Pinghui (University of Science and Technology of China)

Presenter: Mr LI, Yuanjie (University of Schience and Technology of China)

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