Australasian Conference on Computational Mechanics (ACCM)
Brisbane, Australia, Nov 30 to Dec 1 2015

Vortrag/Poster
FE.5339.0001.0012 31.03.06

Identification of mechanical parameters of advanced ceramic pebble beds using DEM

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A tritium breeding blanket (BB), ensuring tritium breeding self-sufficiency, is a compulsory component for the DEMOnstration Power Plant (DEMO). Presently, two tritium breeder concepts (solid breeder blanket and liquid metal breeding blanket) are considered to be tested in ITER (International Thermonuclear Experimental Reactor). In the solid breeder blanket concept, the ceramic breeding material is in the form of a pebble-packed bed with pebble sizes of about <1mm. A thorough understanding of the thermal and thermo-mechanical properties of the ceramic breeding pebble beds in fusion relevant conditions is essential for the design of the breeder blanket modules of the future fusion reactors. After a review of the existing literature and the evaluation of known measurement principles for the evaluation of the effective thermal conductivity of granular materials, an experimental set-up based on the transient hot wire method has been designed and assembled. Simultaneous measurements of the thermal conductivity and stress/strain properties were conducted. The experimental facility allows the investigation of the thermal conductivity under compressive load up to 6 MPa by means of a universal testing machine. The pebble bed is compressed in the axial direction by a piston connected to the movable crossbar of the testing machine. For the design of the breeder blanket, computer simulation tools able to simulate the mechanics of random packed granular materials are needed. A discrete element method (DEM) code and an identification method of material parameters were developed. In this study the numerical simulations are conducted and compared with the experimental results.