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3D Modeling of asphalt materials at the mesoscale

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To describe the mechanical behaviour of asphalts it is mandatory to numerically reproduce their internal structure, namely the location of bitumen and aggregates and voids. Subsequently, it is necessary to develop a sound mechanical prediction of creep, through a correct evaluation of the stress concentration among the inclusions and the voids within the domain of interest [1]. The mechanical behaviour at medium-to-long-term of asphalt is studied in the present work in a 3D mesoscale approach, by explicitly modelling the composite material as a cluster of aggregates (the coarse fraction is considered, for computational reasons) and bitumen surrounding them. The internal structure of an asphalt sample can be reproduced via a random disposition of inclusions, satisfying a given grading curve and a known volume fraction, as proposed in [2], when more sophisticated techniques are not available.
In agreement with recent viscoelastic formulations [3, 4] a novel visco-elasto-plastic constitutive model has been developed, where the viscoelasticity is accounted for via a fractional formulation, i.e. through a parabolic-dashpot-based mechanical representation. The subsequent non-integer order differential model is treated with the Grünwald definition of fractional derivatives. Long term effects have been carried out under different monotonic and cyclic load conditions, based on some relevant experimental tests. The model itself accounts for a better understanding of the inclusions interaction within asphalt under different compressive external loads.

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