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Modelling of kinematic hardening of two phase elastic viscoplastic composite by the additive tangent interaction law : validation based on RVE Finite Element calculations

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In the present contribution, we consider a two phase particulate composite material, whose phases have an elastic-viscoplastic behavior. The local phase model is described by a combined kinematic isotropic hardening law. The Prager-Ziegler linear hardening rule is adopted. It should be mentioned that the work can also handle N-phase composite, but for illustrative purpose, we concentrate only on two phase material.

To model the response of the composite, two approaches are proposed and compared. First, representative volume elements with 30 inclusions are generated, as in Czarnota el al [1]. For the present approach, the local behavior of each phase has been implemented in Abaqus using a UMAT subroutine. Second, the additive tangent interaction law together with a Mori Tanaka scheme is extended to account for combined kinematic and isotropic hardening. Note that the additive tangent Mori-Tanaka scheme, proposed in Mercier and Molinari [2] and revisited in Kowalczyk-Gajewska and Petryk [3], has shown some efficiency to deal with cyclic response of a particulate composite. [1]

In the present talk, the viscoplastic response of both phases is governed by the overstress Perzyna model, where strain rate effect and plastic hardening are accounted for. A large number of simulations have been performed, so as to evaluate the efficiency of the proposed scheme when kinematic hardening is added. Accuracy of the modeling will be discussed.

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REFERENCES

[1] C. Czarnota, K. Kowalczyk-Gajewska, A. Salahouelhadj, M. Martiny, S. Mercier. Modeling of the cyclic behavior of elastic-viscoplastic composites by the additive

tangent Mori-Tanaka approach and validation by finite element calculations Int. J. Solids and Structures (2015). 96-117

[2] S. Mercier, A. Molinari, Homogenization of elastic-viscoplastic heterogeneous materials : Self-consistent and Mori-Tanaka schemes, Int. J. Plasticity 25 (2009), 1024-1048.

[3] K. Kowalczyk-Gajewska, H. Petryk, Sequential linearization method for viscous/elastic heterogeneous materials, Eur. J. Mech. Solids/A. 30 (2011), 650-664.