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# Modeling of the cyclic behaviour of elastic viscoplastic composites by an additive tangent Mori Tanaka approach

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This work deals with the prediction of the macroscopic behavior of two-phase composites, based on the Mori-Tanaka scheme combined with an additive [1]/sequential interaction [2] rule and tangent linearization of viscoplastic response[3]. Cyclic tension compression loadings are considered to further evaluate the approach. The composite is made of spherical inclusions dispersed in a matrix. Both materials have an elastic-visco-plastic behavior. In the second part, finite element calculations are performed using ABAQUS/STANDARD software in order to validate the proposed homogenization technique. A representative volume element is analyzed with 30 randomly distributed inclusions, as in [4].

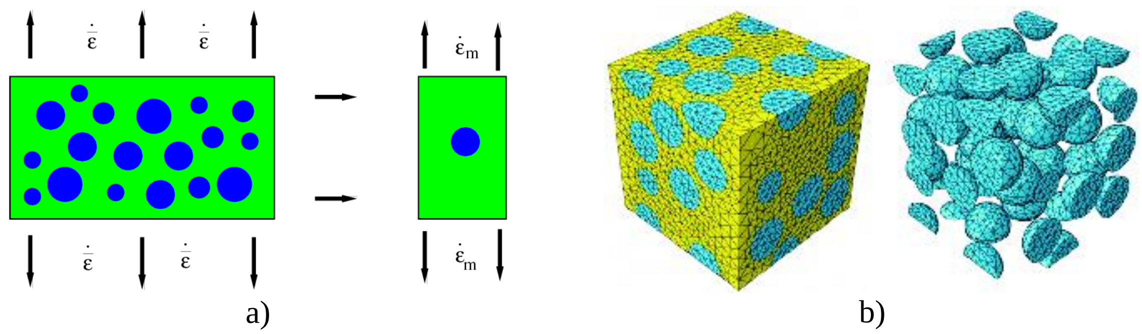


Figure 1: a) Schematic representation of the composite. Spherical inclusions are dispersed in the matrix phase. b) Representation volume element with 30 inclusions. The RVE presents a periodic structure with respect to the three cubic axes.

Comparisons between the additive tangent Mori-Tanaka scheme and finite element calculations are made for different volume fractions of inclusions (10% and 25%), different contrasts in elastic and viscous properties and different strain rates and strain amplitudes.
In the present talk, it will be shown that these comparisons demonstrate the efficiency of the proposed homogenization scheme [5].

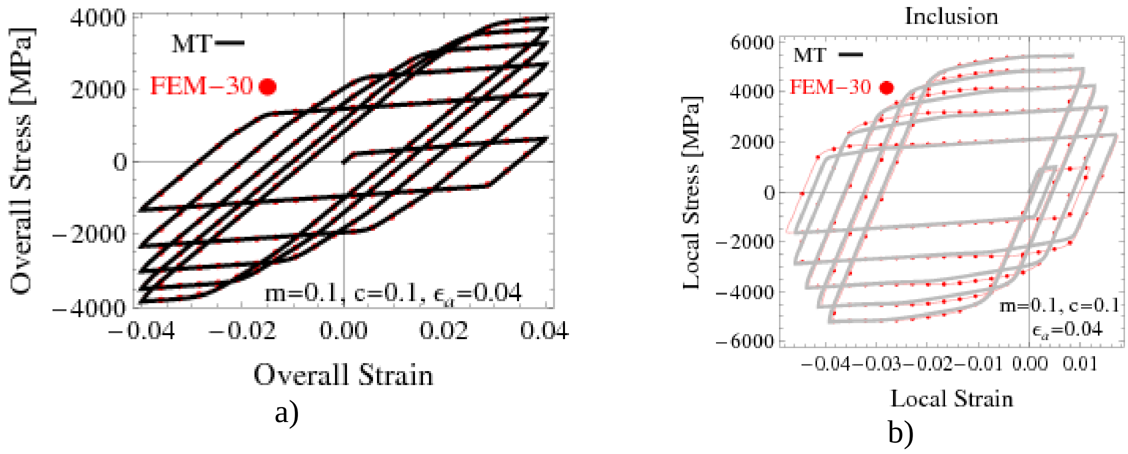


Figure 2: Stress stain curves for a two phase composite with 10% of inclusion phase a) Macroscopic response. b) Stress-strain in the inclusion domain. Multiple tension-compression with a strain amplitude of 0.04 at a strain rate of $10^{-3}$ $s^{-1}$ are performed. Predictions of the additive Mori-Tanaka approach (MT) are compared to results of the FEM model based on the 30 inclusion RVE (see Fig 1b). The strain rate sensitivity of both phases is m=0.1. The inclusion is harder than the matrix. Both phases have elastic-viscoplastic behaviors described by the Perzyna type law [5].

The effect of isotropization of the viscoplastic tangent stiffness is also investigated, based on approaches proposed in the literature [6,7]. It is concluded that quality of predictions does not benefit from such simplification, contrary to the known result for elastic-plastic case.

As a conclusion, it will be shown that the average stress-strain response in each phase can be estimated precisely. For the considered case, depending on the strain amplitude of the cyclic loading, discrepancy may exist during the first few cycles, (see Fig 2b) but after some cycles, predictions are observed to be satisfactory.

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