

On the Virtual Power Principle for RVE-based multiscale models

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ABSTRACT

A virtual power principle is formulated targeting multiscale problems in a rather general setting. The variational foundations are supported on three-pillars: (i) the definition of the kinematics in the different scales, their connection through proper insertion operators and a sense of kinematic conservation through proper homogenization operators; (ii) the use of duality arguments to define admissible internal and external loads, defined by means of the internal and external virtual power functionals, respectively; and (iii) the statement of a virtual power principle establishing energetic consistency between the scales [1].

The proposed multiscale virtual power principle embodies, and extends, the well-known Hill-Mandel principle of macrohomogeneity. Furthermore, the multiscale virtual power principle delivers through natural variational consequences: (i) the homogenization formulae for stress-like quantities, (ii) the homogenization formulae for body force-like quantities, and (iii) the virtual power principle that correctly defines the equilibrium at the micro scale.

The so developed multiscale variational theory allows to tackle problems involving macro and micro body forces, different kinematics between macro and micro scales, and failure mechanisms at macro scale generated by failure mechanisms taking place at the micro scale [2]. Analogously, multiscale models of continua in fluid mechanics can naturally be formulated from the proposed theory [3]. Examples of these situations will be discussed.

REFERENCES

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