Gradient theory of mechanics of solids: fields of defects and damage modeling.

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Introduction. Corrected procedure of account of the damage accumulation based on the general model of mediums with conserved defects is offered. We use the multiscale continuous media model with conserved dislocations[1,2] which allows to describe three types of dislocations which reflects the connection of dislocations with distortion, with change in volume (porosity), and with twisting (curls or spins). Advanced model of continuum mediums has been successfully applied to prediction/modeling of cohesion type interactions and both cohesion and adhesion superficial interactions. We established, that for the fracture mechanics proposed gradient model describes the non-singular equilibrium crack of Barenblatt types and gives the strong theoretical justification for famous hypothesis of Barenblatt about cohesion field near top of non-singular cracks[2].

Methodology. In this work we develop the variant of the damage accumulation model and degradation of the mechanical properties model for deformable bodies, which on the one hand takes into account the evolution of the fields of defects (field of various types of dislocation) and on the other hand enables us to receive the estimation of influence of damage on the effective properties of the material. We define the tensor of second rank of damage, which is used as the kinematic variable for the formulation of the variational model of damage and prove the equivalence of the gradient elasticity model and the model of the inhomogeneous classical medium with variable elastic moduli, which depend on the parameter of the tensor of damage. As a result, the model the media with the field of defects- dislocations is developed as the classic model of an inhomogeneous medium. Tensor of modules of such the inhomogeneous medium is represented as an explicit function of the tensor of damage and tensor parameters of the gradient model. The applied variants of the damage model, when the problem of determining the tensor of damage and degradation properties can be solved sequentially using the method of successive approximations are considered.

Applications. As a example the failure determined by porosity is modeled and appropriate variant of gradient model of plasticity (damage) is developed. The problem of degradation of material properties for the mediums with field of oriented defects (porous) is considered. The effects of changing of the mechanical properties of laminated structure due to the damage accumulation also are estimated.

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