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Strain analysis and structural optimization of functionally graded rod with small concentration of inclusions

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Abstract: The homogenization procedure is applied to strain analysis and optimal design of a Functionally Graded (FG) rod in the case when the inclusion size is essentially less than a distance between them. The method is illustrated using an example of the rods longitudinal strain. We considered separately the cases of FG inclusion sizes and FG steps between inclusions. Two particular problems of optimal design are discussed in some details. Introduction the steps function allowed solving problems of computations and optimal design of FGS with a FG inclusion dimensions and FG steps between inclusions using the unique approach. Both considered problems occurred from the mathematical points of view identical ones, whereas the difference between them consists in the meaning of coefficients in the state equations and control functions. While optimization the FGS with FG inclusion sizes and FG steps between inclusions it is recommended to search the control function on a set of piece-wise continuous functions. The optimization process is realized with a help of two mechanisms. First, we define boundary area where inclusions do not occur. Second, in the case of FG inclusion sizes we interlace inclusion dimensions to fit a rule of the external load distribution. In the case of FG steps between inclusions should be decreased on the part associated with large intensity of the external load. The reported optimization mechanisms, being obvious from physical point of view, have found a mathematical foundation in our work.

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