Element energy based method for topology optimization

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A simple topology optimization method for minimization of structural compliance at given volume is proposed. The solution of minimum-compliance problem with given volume under the fixed external loads and self-weight leads to obtaining “grey” solution. The particular difficulties also arising in the considered topology problems are non-monotonous behavior of the compliance and the parasitic effect for low densities when using the power model. It is necessary to modify the power law model for all range of densities.

The optimization problem is formulated in new design variables. The solution of this problem is based on the derived updating formula in which the gradients are calculated with respect to new variables. New approximation of the obtained expression has been derived for very large power parameter. In this case the recurrence formula of the algorithm is simplified. The simple procedure for determination of the Lagrange multiplier is proposed. Based on these ideas the algorithm for topology optimization is developed. It includes the possibility to control topology layout in addition to the filtering procedure.

The proposed method has been demonstrated on several example problems. For cantilever and MBB examples the obtained optimal solutions are better than those obtained with the ESO and continuation SIMP algorithms. It is shown also that the topology optimization problem with only self-weight loads can be solved efficiently by using the method. The optimal solutions are better for further engineering interpretation and can be obtained more efficiently. The Wolfram Mathematica code is given.