PHASE FIELD APPROACH TO TOPOLOGY OPTIMIZATION OF CONTACT PROBLEMS

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Abstract

The paper deals with the topology optimization for an elastic body in unilateral contact with a rigid foundation. This optimization problem consists in finding such topology of the domain occupied by the body and/or the shape of its boundary that the normal contact stress along the boundary of the body is minimized.

In structural optimization the level set method [1,3] is employed in numerical algorithms for tracking the evolution of the domain boundary on a fixed mesh and finding an optimal domain. This method is based on an implicit representation of the boundaries of the optimized structure, i.e., the position of the boundary of the body is described as an isocountour of a scalar function of a higher dimensionality. The evolution of the domain boundary is governed by Hamilton - Jacobi equation. The speed vector field driving the propagation of the level set function is given by the Eulerian derivative of the cost functional with respect to the variations of the free boundary. Applications of the level set methods in structural optimization can be found, among others, in [3].

In the paper phase field approach is proposed to regularize the level set based topology optimization problem and to solve it. This approach consists in using the Cahn-Hilliard energy term [2,4,6,7] in the cost functional as the regularization term rather than the perimeter constraint. The regularization for topology optimization of contact problems has been considered in [5] to calculate the topological derivative of the cost functional. Moreover the proposed regularization of Tikhonov type leads to optimal topologies having suitable smoothness. Derivatives formulae of the cost functional with respect to level set function are calculated. These derivatives are employed to formulate necessary optimality condition for topology optimization and to calculate descent direction in the numerical algorithm. Details of numerical implementation are provided. Numerical examples are provided and discussed.

References

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