A variational method for the topology optimisation problem

David Portillo*[1], Edmund Bell-Navas[1], and Ignacio Romero†[1]

[1]Technical University of Madrid – Spain

Abstract

The numerical solution of topology optimization problems is plagued with difficulties that result from the ill-posedness of the continuous problem. Many of the strategies leading to the most common and successful numerical methods for topology optimization are essentially regularization techniques that yield robust numerical approximations to a solution of the continuous boundary value problem.
In this talk, we will describe a new numerical technique that approximates the solution to the topology optimization problem of small-strain mechanics by transforming it into a well-posed evolution problem and later approximating its solution with a time integration scheme based on an incremental variational principle. With this procedure, the topology optimization solution will be obtained through a sequence of discrete optimization problems, each of them well-posed. Once the variational principle is posed, no other regularization or filter will need to be employed, as customary in other approximations.

The numerical discretization that we propose pivots on identifying a unique incremental functional whose stationarity conditions determine the evolution of the optimal density field. This approach has several advantages as compared with other numerical solutions of topology optimization: first, the incremental functional simplifies the mathematical analysis of the problem; second, its numerical solution by means of Newton-Raphson type methods invariably gives rise to symmetric tangents, which can be exploited for efficient numerical methods.
The numerical performance of the proposed framework will be illustrated by optimising a series of structures of minimum compliance and fixed mass. Its solutions will be compared against those obtained with standard numerical methods such as SIMP and Allen-Cahn phase-field-type methods.

*Speaker
†Corresponding author: ignacio.romero@upm.es