Computational design of microstructure for the optimization of the temperature-dependent macroscopic response

Víctor D. Fachinotti*, Sebastián M. Giusti†, Facundo Bre*, Alfredo E. Huespe*

*Centro de Investigación de Métodos Computacionales (CIMEC-UNL-CONICET)
Predio CCT-CONICET, Colectora Ruta Nac. 168, CP 3000, Paraje El Pozo, Santa Fe, Argentina
vfachino@intec.unl.edu.ar, facubre@cimec.santafe-conicet.gov.ar, ahuespe@intec.unl.edu.ar

† Dept. of Civil Engineering - GIDMA, National Technological University (UTN), Córdoba Regional Faculty/CONICET, Maestro M. López esq. Cruz Roja Argentina, Ciudad Universitaria, X5016ZAA, Córdoba, Argentina, sgiusti@civil.frc.utn.edu.ar

ABSTRACT

This work is addressed to the optimization of the steady-state, thermal response of a macroscopic body by altering the parameters that define the macroscopic thermal conductivity, which is allowed to vary throughout the body. Mathematically speaking, it is an optimization problem where the goal function depends on the macroscopic temperature field and the design variables are the parameters defining the macroscopic thermal conductivity at a series of sampling points embedded in the body.

Every evaluation of the goal function amounts to solve a macroscopic thermal problem using the finite element method, where each node of the mesh is allowed to have a different conductivity, characterized by a finite (usually few) number of parameters. The whole set of design variables consists of all the parameters defining the thermal conductivity of all the nodes of the mesh.

In this case, the macroscopic thermal conductivity is allowed to be, in general, orthotropic. Since only 2D problems are addressed in this work, the macroscopic conductivity is completely defined by three micro-parameters: its two principal values and the orientation of one of the principal axes.

As an example of application, we solve an optimization problem in a given 2D domain with given boundary conditions in order to determine the conductivity distribution that makes the temperature attains a given value at a given point of the domain.