A novel strategy to optimize shapes using Genetic Algorithms and the Finite Element Method

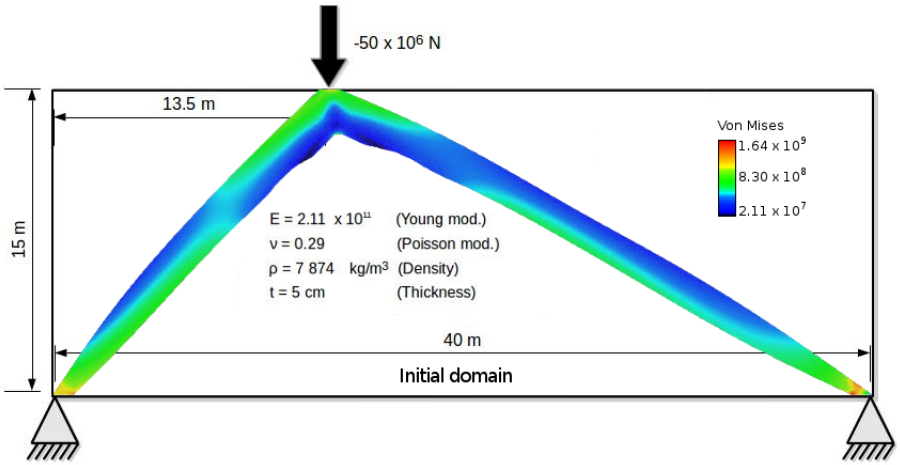
Victor Cardoso*, Ivvan Váldez, Salvador Botello, Arturo Hernández.
Centro de Investigación en Matemáticas A.C.,
Jalisco S/N, Col. Valenciana, Zip 36240,
Guanajuato, Gto., Mexico,
email: victorc, ivvan, botello, artha@cimat.mx, web: www.cimat.mx

Abstract

Shape optimization is the design process to obtain an optimal structure under specific conditions, such structure must have the minimum weight without exceeding the maximum allowed Von Mises stress and displacement. In our procedure, the analyzed structure is defined by a set of control points, we apply the α-shape method to them in order to get the contour of the shape. To search for optimal structures, we use a set of N potential control points, then a Genetic Algorithm is used to find the subset of control points which best describes the optimum, each binary gene is related with a single control point indicating if it is included in the subset. The potential control points are equispaced distributed across the initial domain and the chromosomes are randomly initialized with N binary genes. Each chromosome defines a geometry, in consequence a new mesh must be generated for each candidate solution. The Finite Element Method is used to evaluate the shapes codified by the chromosomes. The results from this novel approach are competitive with similar proposals in the literature.

Balamurugan et al. presents a similar approach with a Two Stage Adaptive Genetic Algorithm in structural topology optimization [1], Valdez et al. estimate the search distribution with EDAs also for structural topology optimization [2], and Talischi et al. uses polygonal elements to generate, analyze and evaluate the structures [3].

The following figure shows the structure obtained with the proposed methodology for some given conditions.



References

[1] R. Balamurugan, C. Ramakrishnan, N. Singh, "Performance evaluation of a two stage adaptative genetic algorithm (TSAGA) in structural topology optimization". Applied Soft Computing, 8(4): 1607-1624, 2008, 1586-4946.

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