

## Explicit feature control in structural topology optimization

X. Guo <sup>\*</sup>, W.S Zhang <sup>1</sup> and W.L. Zhong <sup>1</sup>

<sup>1</sup> State Key Laboratory of Structural Analysis for Industrial Equipment,  
Department of Engineering Mechanics,  
Dalian University of Technology, Dalian, 116023, P.R. China,  
guoxu@dlut.edu.cn

**Key Words:** *Topology optimization; Feature control; Level-set; Signed distance function.*

Topology optimization of continuum structures, which is, in its mathematical nature, a discrete optimal control problem of the coefficients of partial differential equations in infinite dimensional space, is the most challenging structural optimization problem. One long standing problem in structural topology optimization, which is closely related to regularization, is feature control of optimal structural topology. The goal of feature control is to restrict the length scales appeared in the optimal structure (e.g., the minimum/maximum cross sectional area of the structural members, the minimum/maximum radius of the holes) and therefore make the resulting optimal designs more reliable and manufacturable. The present paper aims to develop an efficient, no post-processing/continuation, local and explicit scheme for complete control of the feature sizes in topology optimization which can, at the same time, generate pure 0-1 designs. The basic idea is to resort to the level set solution framework and impose constraints on the extreme values of the signed distance level set function used for describing the topology of the structure. Numerical examples show that the proposed method can give a complete (i.e., minimum and maximum length scales) control of the feature sizes in the optimized structures.

### REFERENCES

- [1] M.Y. Wang, X.M. Wang, D.M. Guo, A level set method for structural topology optimization, *Comput. Method Appl. Mech. Engrg.* Vol. **192**, pp. 227–246, 2003.
- [2] G. Allaire, F. Jouve, A.M. Toader, Structural optimization using sensitivity analysis and a level set method, *J. Comput. Phys.* Vol. **194**, pp. 363—393, 2004.
- [3] J. Petersson, O. Sigmund, Slope constrained topology optimization, *Int. J. Numer. Methods Engrg.* Vol. **41**, pp. 1417 - 1434, 1998.
- [4] T.A. Poulsen, A new scheme for imposing minimum length scale in topology optimization, *Int. J. Numer. Methods Engrg.* Vol. **57**, pp. 741 - 760, 2003.
- [5] J.K. Guest, Achieving minimum length scale in topology optimization using nodal design variables and projection functions, *Int. J. Numer. Methods Engrg.* Vol. **61**, pp. 238-254, 2004.
- [6] J.K. Guest, Imposing maximum length scale in topology optimization, *Struct. Multidiscip. Optim.* Vol. **37**, pp. 463-473, 2009.
- [7] S.K. Chen, M.Y. Wang, A.Q. Liu, Shape feature control in structural topology optimization, *Comput. Aided Design* Vol. **40**, pp. 951-962, 2008.

- [8] X. Guo, W.S. Zhang, W.L. Zhong, Explicit feature control in structural topology optimization via level set method, *Comput. Method Appl. Mech. Engrg.* under revision, 2013.

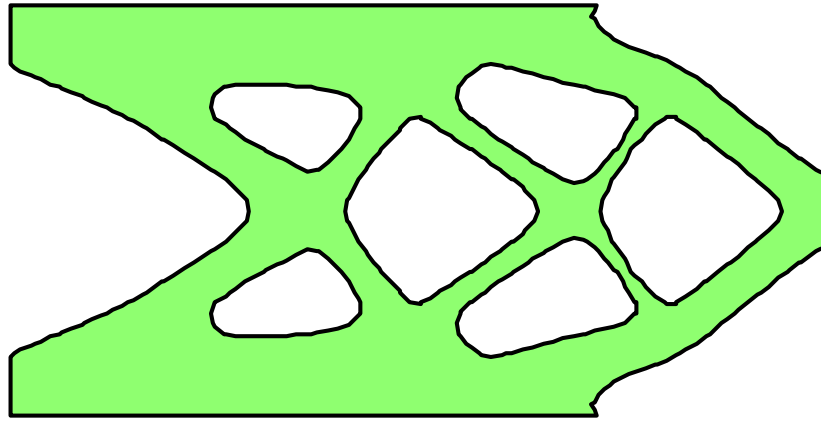


Fig. 1 The optimal design of the short beam example without feature control.

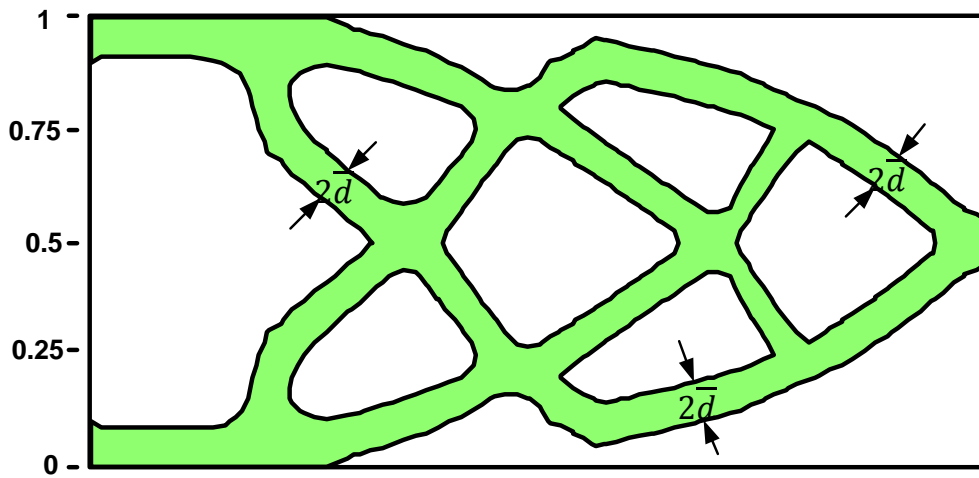


Fig. 2 The optimal design of the short beam example with feature control