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A HEURISTIC APPROACH TO SUBDOMAIN ORIENTED MULTI-MATERIAL TOPOLOGY OPTIMIZATION

Katarzyna Tajs-Zielinska, Bogdan Bochenek

Cracow University of Technology, Poland
katarzyna.tajs-zielinska@pk.edu.pl, bogdan.bochenek@pk.edu.pl

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Abstract: Developing novel methods, approaches and computational techniques is essential for solving engineering problems efficiently. This is important issue especially nowadays when emerging problems become more and more demanding. As the example of a fast and intensively developed optimization tool may serve a topology optimization, which allows to develop new, innovative layouts of considered designs. The idea is to find within a defined design domain the distribution of material that is optimal according to the assumed criterion or criteria. The optimized structure gains new shape and material layout, since some parts of material are relocated and others are selectively removed. The vast majority of reported in literature solutions regard structures made of one material. On the other hand, allowing for implementation of multi-material structures may open new possibilities for improving existing solutions. The typical approach is a redistribution of materials within a whole design domain. This conventional concept of topology optimization is extended in the present paper by introducing the idea of 'subdomain oriented multi-material topology optimization'. The design domain is divided into regions for which different types of material are defined and through this procedure the multi-material structure is created. The challenge of the present research is to find optimal topologies, under restriction that redistribution of material can be performed only within subdomains selected for employed materials. What is very important, in terms of practical applications, it is possible to impose constraints on volume fraction of each defined material. Obtained results of preliminary numerical studies show, that this approach produces different results as compared with classical single-material problems. The effectiveness of topology optimization process is determined by proper choice of numerical optimization algorithm. This paper utilises very efficient and versatile heuristic method called Cellular Automata (CA). The main advantage of the CA algorithm is that, it is an easy to implement, fast convergent technique and usually requires less iterations as compared to other approaches to achieve the optimal solution. There are also not many parameters to adjust what is important for practical applications. In addition, included self-weight loading makes considered design problems more practical and realistic. The implementation of self-weight loading has a significant influence on the final results of topology optimization process, what is very important especially when dealing with the optimization of massive engineering structures.