EngOpt2018 - 6th International Conference on Engineering Optimization
Instituto Superior Técnico, Lisbon Portugal • 17-19 September, 2018
Editors: H.C. Rodrigues, J. Herskovits, C.M. Mota Soares, et al.

Abstract ID 1246

FINITE ELEMENT SIMULATION AND TOPOLOGY OPTIMIZATION OF BIOINSPIRED STRUCTURES UNDER LOW-VELOCITY IMPACT

Francisco Ramírez-Gil, Esteban Foronda, Wilfredo Montealegre

Universidad Nacional de Colombia, Colombia
fjramireg@unal.edu.co, eforondao@unal.edu.co, wmontealegrer@unal.edu.co

Keywords: Transient dynamics,Explicit finite element method,Topology optimization,Bioinspired design

Abstract: Nature has proven to be a successful designer of materials and structures. As consequence, humans have tried to replicate this type of structures through the bioinspired design. This led to the development of the functionally graded materials (FGM), a new type of composites in which the microstructure, composition, porosity or other characteristic is changed continuously through one or more directions, allowing a smooth variation of properties over the volume. In this research, the concept of FGM is explored for low-velocity impact applications, in which the objective is to reduce the weight of a plate and enhance (or at least keep) it effective stiffness. Although there are different strategies to design FGMs, in this study the volume density of the structure is changed from surface to core by controlling the porosity through inserting holes. This is a common method used by nature in structures subjected to impact such as bones, teeth, horns and wood, and also by man-made products such as metal foams due to their potential for lightweight and energy absorption. Two approaches are proposed herein to reach the objective. The first one consists in generating several patterns of holes intuitively, and the second one generates these holes' pattern through topology optimization. An explicit finite element analysis is used to simulate the low-velocity impact and the comparison is done with plates without holes. Different load cases are evaluated, studying the effect of subjecting the plate to localized or distributed loads. The results show that it is possible to design the patterns of holes reducing the weight of the plate without having a substantial detriment on their structural response. These results can be used to design components in applications where weight reduction is a priority and it must be balanced with the impact energy absorption capability. Finally, further research should be developed so that this design technique can be applied to components subjected to medium- and high-velocity impacts, including contact, plasticity and failure criteria.