Reliability-based Structural Design in vibration and performance in fatigue

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In the world of rapid prototyping and additive manufacturing greatly developed in recent years, it is interesting to study the potential of optimization methods in the vibrational design and the consequence on the fatigue life of mechanical components. Optimization techniques could provide the best structural topology with optimal performance requirements such as strength, stiffness, weight, natural frequency, or buckling. Many methods exist in the literature. For example, the well-known topology optimization [1,2] that plays an important role in structural design and analysis. It is a way to obtain interesting design alternatives. Figure 1 have been used as an example to economize material with the better design. Topology optimization is a potential technique for improving the structural performance, since it allows modifying in the connectivity of the geometry of the structure during the design process.

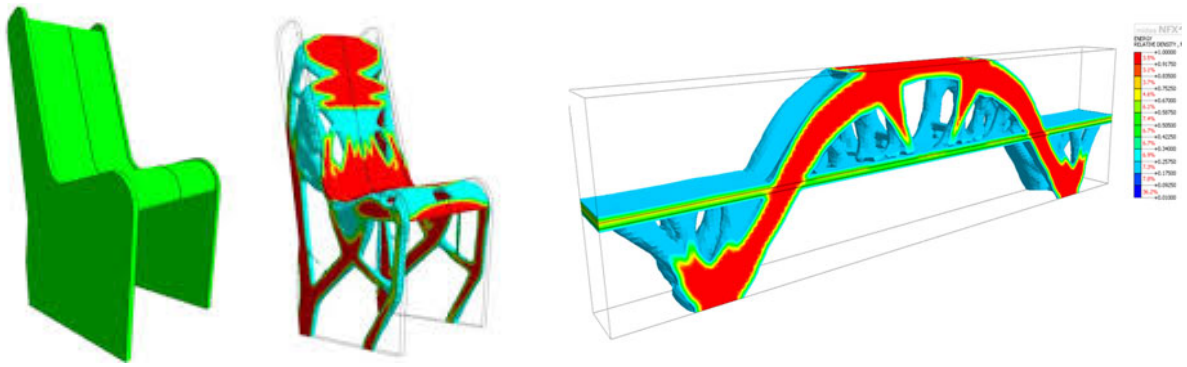

Figure 1 : Example of topology optimization applied on a chair or a bridge (http://www.midasnfx.com/)

Others alternatives such as the Reliability-Based Design Optimization (RBDO) lead to find the best design with optimal cost and safety assurance, based on structural reliability theory to take account the uncertainties. Other like the Reliability-Based Topology Optimization (RBTO) are known as the most rigorous approach for topology optimization because they consider the random nature of the loading fluctuations, the material properties and the geometrical dimensions. At now, several works focus on developing efficient RBTO formulations [3-5].

The main objective of the work is to develop an efficient procedure based on the structural approach based on reliability to obtain a best design of a component submitted to vibrations. This objective remains a challenge because this design should also have good performance in terms of fatigue life. Several strategies based on the bibliographic study will be investigated to improve this procedure and to propose an efficient procedure to reach a reliable component.

Some article related to this topic:

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Teddy Tsai, Chih-Chun Cheng. Structural design for desired eigenfrequencies and mode shapes using topology optimization. Struct Multidisc Optim DOI 10.1007/s00158-012-0840-2

George I. N. Rozvany, Tomasz Lewinski. Topology Optimization in Structural and Continuum Mechanics. Book.

Jong Wook Lee, Gil Ho Yoon, Seung, Hyun Jeong. Topology optimization considering fatigue life in the frequency domain. Computers & Mathematics with Applications. Volume 70, Issue 8, October 2015, Pages 1852-1877.

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