Implementation of Equivalent Load Scheme for easy prediction of minimal compliance topologies in the presence of random loads

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In engineering applications, load randomness is a frequent issue and represents a key aspect that has to be considered in the design process in order to guarantee the required stiffness and durability of structural components. This issue can be addressed in various ways [1], and the convenient approach to deal with this type of the problem is to mimic random loads using multiple deterministic load cases. However, in order to adequately capture the stochastic nature of acting load, it is usually necessary to consider several hundred of load cases, which significantly increases the computational demand. The following article presents an easy to implement alternative concept that could reduce the computational time. The Equivalent Load Scheme (ELS) is a conceptual framework employed for predicting the structural topology of systems subjected to random loads. The ELS proposes a limited number of appropriately selected deterministic load cases that facilitates the replacement of a multitude of random ones. Although this approach is heuristic, it ensures a high degree of consistency with the classical multi-load approach, while allowing for reduction of the computational cost. The efficacy of the method has been validated by performing a multitude of numerical tests, encompassing a broad spectrum of structural complexity. These examples include two-dimensional structures, as well as realistic spatial engineering structures [2,3]. In each analysis, the results obtained based on random loads and their ELS equivalents were compared. The obtained topologies were practically identical, and the differences in compliance values did not exceed a few percent. The results confirmed that the presented ELS concept can be regarded as a useful alternative to the existing techniques, significantly simplifying the design process. This approach offers also an additional advantage, namely the possibility of using any algorithm or commercial software that allows finding topologies with minimum compliance involving multiple load schemes. In this paper the authors employ Cellular Automata as the minimal compliance topology generator. The ELS method is thus a practical, universal, and easily implementable tool that allows for rapid and effective prediction of the topology of structures under loads subject to random changes. Moreover, its adaptability to both simple and highly complex geometries demonstrates that the approach remains robust across diverse engineering scenarios, further enhancing its relevance for practical applications.

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