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SENSOR PLACEMENT FOR STRUCTURAL DAMAGE IDENTIFICATION BY MEANS OF TOPOLOGY OPTIMIZATION

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Damage identification attracted a lot of attention during the last three decades. The reason for that is the fact that large number of existing civil infrastructures reached their service life and growing number of structures is equipped with Structural Health Monitoring (SHM) systems. A successful structural damage identification is determined by three inseparably coupled factors: sensor placement, damage location and its extend, and finally location and time-frequency characteristics of the applied excitation.

The purpose of this study is to address the first of the mentioned aspects, namely optimal sensor placement. A vast literature has been devoted to optimal sensor placement methods among which Effective Independence (EI) method proposed by Kammer and Tinker [1] is one of the most successfully applied in practice. However, EI method is dedicated rather to test-analysis correlation and therefore more specific methods for damage identification are still needed. Additionally, in the case of large civil structures, which are intended to be equipped with large amount of sensors of different type, other sensor placement methods can be more efficient. Recently, a promising idea of utilizing a topology optimization approach for the purpose of sensor placement has been proposed by Bruggi and Mariani [2]. The goal of this study is to extend their method, which has been verified on a plate structure, to the case of a FE model of a real arch bridge structure consisting a few thousands degrees of freedom.

The main purpose of this work is to find the optimal arrangement of sensors on the structure to detect defects most accurately. The objective function for the problem formulated in this way is the total, weighted difference between the deformation of a damaged and undamaged state. This problem is very similar to the topological optimization, where we search for the optimal material distribution minimizing the mass of the structure while meeting the conditions related to some mechanical properties such as the maximum displacement of the structure, stress intensity or load capacity. This similarity led us to apply topological optimization to the problem of optimal placement of damage sensors. Several numerical examples prove the applicability of topological optimization for optimal sensor placement problem.

References

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