Design Optimization of Structures utilizing Dynamic Substructuring and Artificial Intelligence Techniques

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Introduction

The well known property of resonance is causing large displacements which indicates large strains and large stresses in mechanical systems. This may lead to the failure of the structure. Resonance conditions can only be tackled by changing the design of the structure.

Objective

Development of an efficient design optimization strategy for large scale structural dynamics problems.

Strategy, Application & Results

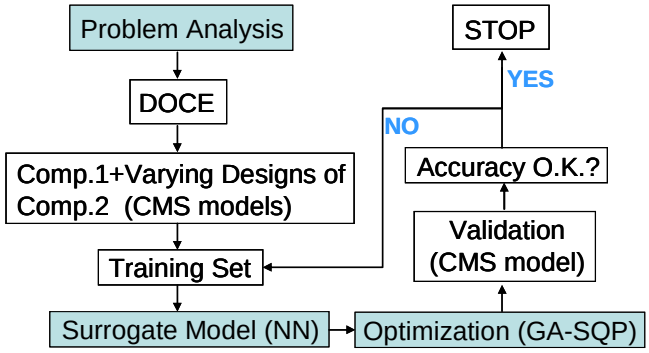

Figure 1:Design Optimization Strategy

Strategy: The optimization strategy is illustrated in Fig. 1. In the strategy, utilized abbreviations stand for: Design of Computer Experiments (DOCE), Component Mode Synthesis (CMS), Neural Networks (NN), Genetic Algorithms (GA), Sequential Quadratic Programming (SQP).

Application: To demonstrate the strategy, the first natural frequency of the plate (see Fig. 2) is minimized under the constraint of keeping the total mass constant. The plate is clamped at the boundaries. The design parameters are only located in the second component which are the thickness of the plates, the width and the thickness of the ribs and the distance between the ribs. The CMS technique based on Craig-Bampton method is utilized for coupling the first component with the varying designs of the second component and obtaining a structural response for the training set(see Fig. 1).

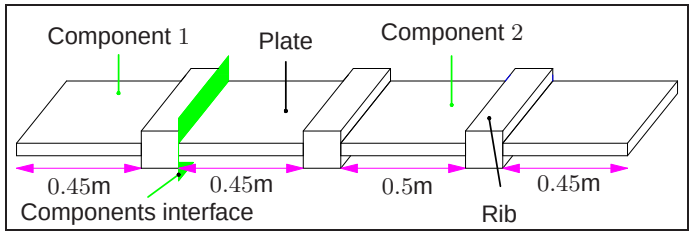

Figure 2:Application

Results: The first natural frequency is reduced from 357.89 Hz. to 71.61 Hz. by the modification of the plate thicknesses and the thickness and the width of the first rib in the second component (see Fig. 3).

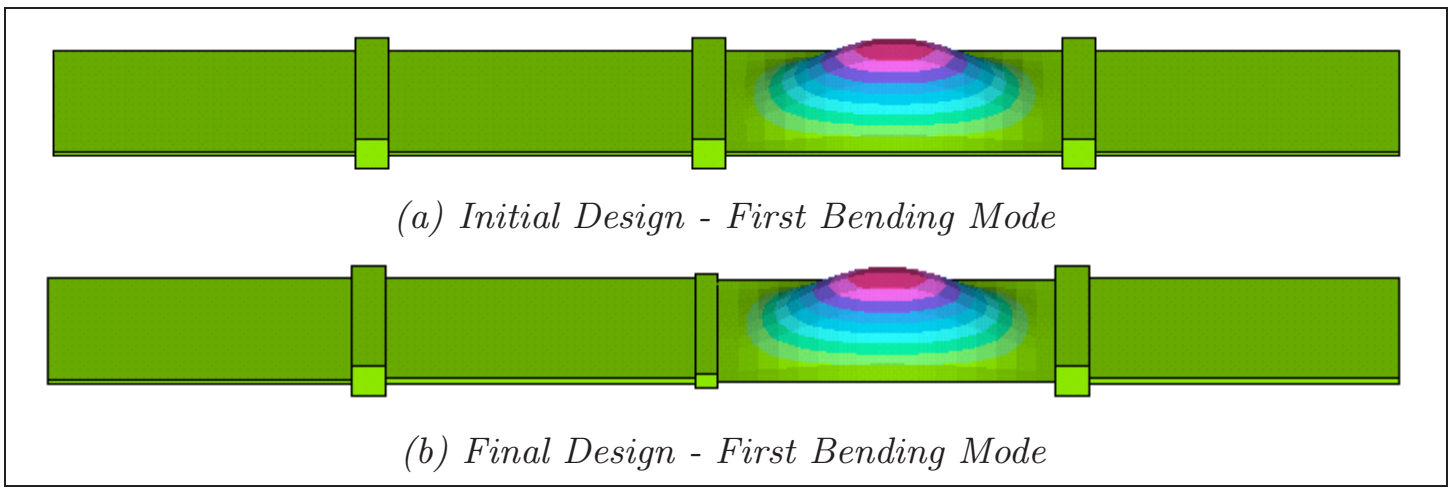

Figure 3: Results