

Optimal Design of a Parallel Beam System with Elastic Supports to Minimize Flexural Response to Harmonic Loading

Bret R. Hauser¹, Bo P. Wang²

¹ University of Texas at Arlington, Arlington, TX, USA, bret.hauser@tx.rr.com;

² University of Texas at Arlington, Arlington, TX, USA, bpwang@uta.edu;

Abstract

Mechanical systems subject to vibration are prevalent across many industries. Although potentially different in application, they sometimes share the need to minimize aspects of flexural deformation given harmonic loading and the need to consider a variety of design variable and response-based constraints in the process. Practical design efforts also sometimes include the need for consideration of the optimal response of a platform-style product, including responses of multiple design variants supported by a common base structure. Harmonic problems can be especially challenging to optimize due to the likelihood that the response will be multi-modal; influenced by system natural frequencies throughout the design space. Further, analysis of these systems often involves large and complex computer models which require significant resources to execute. A harmonically loaded, platform-style parallel beam system with multiple family variants is used as an example in this work to demonstrate a proposed method for identifying an optimum in a constrained, multi-modal response environment with consideration for Expensive Black Box Functions (EBBF).

The presented method leverages benefits of a combined approach where the domain is first surveyed for potential areas of optimal response using a method of Steepest Feasible Descent (SFD), followed by a search in the optimal region using direct search methods. The method of SFD is a modification of the classical method of Steepest Descent, made useful for constrained models by a penalty system including both deterministic and programmatic methods. A sensitivity-based search vector method also helps to manage situations where significant difference in magnitude exists among the design variables. Evidentiary support for these key program elements is provided using standardized test functions. The effectiveness of the method is demonstrated by seeking a minimum flexural response for a parallel beam system subject to elastic support and response constraints.

Keywords: harmonic optimization; parallel beam; elastic supports.