



Multilevel Decomposition Model for Optimal Design of Multi-Story Structures

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Abstract

Multilevel decomposition optimization method decomposes a large problem into small subproblems to be solved separately and maintain effects between subproblems effectively by sensitivity derivatives, and it serves as a useful tool for design engineer team to work on a large structural optimization problem simultaneously and effectively. The present paper illustrates the application of this method on the optimization of a portal frame of a multi-story steel structure, and three level of substructure is chosen to solve the optimization problem. The 1st level is the entire structural system constrained to total lateral displacement, the 2nd level is each story frame constrained to story drift, and the 3rd level is related element sizing based on local constraints due to strength, serviceability, and member stability.

Keywords: optimal design; multilevel decomposition model; multi-story structure.

1 Introduction

Structural optimization is one of key aspects of efficient designs, and, with a large numbers of available optimization methods, structural engineer team shall know which approach to adopt in the interest of efficiency in achieving required design goals with limited time and resources. One-level optimization process which requires iterations of the whole structure might be overwhelming, costly, and unmanageable, especially, when it comes to large projects with large numbers of design variables and design constraints.

Multilevel decomposition structural optimization method is the process of partitioning a big problem

(a system) into small subproblems (subsystems), solving them independently and simultaneously, coupling effects between different levels, and iterating whole process to a converged point, and, importantly, this method also provides trackability to the problem solving [1]. This method has been adopted in many works such as optimization of prestressed concrete via two-level optimization [2], steel frame optimization [3], and space truss optimization [4].

In structural design application, a system (an entire structures) is seen as a hierarchical system and is decomposed into several levels. Generally, 1st level is always the entire system (a whole structures) while the lower levels (subsystems) are arranged