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Members Sizing of Optimum Bracing of Fixed-base Steel Frames

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Abstract

To design steel structures so as to make them potent to tolerate lateral loads, lateral load resisting systems are considered which may be in the form of moment frame rigid or semi rigid connections, pre-qualified bracing systems or dual systems. The typical pre-qualified bracing systems are first prescribed based on architectural considerations etc. and then the structural design process is run to size the profiles needed to be assigned to these usually slant members. However, to minimize the material used to fortify the structure against lateral loads, an optimum topology may be determined through optimizing the layout of the lateral load resisting system. The design process can be then performed to determine the sizes of the profiles which are to fill in the optimal topology of the frame. The outcome of this optimal design process, namely topology optimization and corresponding sizing determination, is idealistically a scheme with minimal lateral load bearing material and proper lateral performance of the structure. In this research such a sizing scheme is taken to offer eventual designs of steel frames. The material used to brace frames with constant beams and columns is observed to be considerably less than that used in typical design procedures while the performance of the frames remain logically suitable.

Key words: topology optimization, braced steel frame, member sizing, lateral load, required material.

1. Introduction

Multistory buildings are designed not only for gravity loads but also for lateral loads. In the performance-based design of a multistory building, four major performance requirements such as strength, stiffness, stability and cost must be considered. In the design for vertical loads, the floor system in a building must be strong enough to transfer the loads to the columns or walls and stiff enough not to deflect excessively. Moreover, the floor system must be designed to have sufficient strength and stiffness to brace all columns and walls so that they will not buckle under the design loads. In the design for lateral loads, the structural system must be adequate stiff to resist wind and seismic forces. The strength performance