Experimental performance of optimized trusses

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Abstract

A series of six 3D printed discretely optimized truss specimens and two warren truss specimens were experimentally loaded until failure. The results were compared to the theoretical failure loads and stresses determined using Maxwell's Method. Each set of truss specimens were loaded in a simple span condition, with a point load applied at the center of the span. Each truss specimen was configured into pairs in order to prevent lateral torsional buckling (LTB) while testing. Strain, load, and displacement data was gathered for each truss specimen tested. These results were compared to the predicted results calculated by Maxwell's theorem. Of the 6 specimens tested, all of the trusses failed within 1% - 20% of the analytical vales. The trends in the experimental results support efficacy of previously developed theories of optimized truss topology in order to increase strength and efficiency of lateral systems in high rise structures.

Keywords: Trusses, Optimization, 3D Printing, Maxwell's Theorem, Material Efficiency

1 Introduction

There is growing demand for sustainably designed buildings due to the Janus-faced problem of increasing worldwide urban population and limited global resources. In fact, the global urban population is estimated to increase to 9.8 billion by 2050 [1, 2]. As a result, demand for square footage of the built environment has precipitated ongoing increase in tall buildings construction. Consider that in 2018-2019, 13 of the world's tallest 42 buildings topped out [3]. Such a large quantity of projects and the magnitude of scale highlights why the built environment is responsible for 39% of

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