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An Analytical Method to Estimate the Total Installed Cost of Structural Steel Building Frames during Early Design

Steve Barg[1,2], Forest Flager[2], Martin Fischer[2]

Abstract

This paper presents a new method to quickly and accurately estimate the material, fabrication, and erection cost of steel frames based on early-design information. To use the proposed Integrated Steel Design (ISD) method, engineers first upload a structural model consisting of a frame layout with preliminary member sizes and connection types specified. The frame connections are then automatically detailed to produce a bill of quantities suitable for fabrication. Next, the total installed cost is estimated based on unit rates maintained by suppliers on a secure web portal. Finally, the cost feedback is provided in the context of the 3-D model in near real-time. We apply the proposed analytical method to several moment frames to illustrate its advantages compared to more approximate approaches. These initial results demonstrate the potential of the ISD method to improve early stage design decision-making through better vertical integration of project information in the AEC industry.

Highlights

- Analytical cost estimate based on early-design information
- Automated connection detailing of steel frame structures
- Web portal allows steel suppliers to maintain current cost data
- Cost data visualization in the context of the building information model (BIM)
- Demonstration of the benefits of vertical integration in the AEC industry

Keywords: Steel frame; design automation; cost estimation; structural optimization; steel detailing; building information modeling; BIM

1. Introduction

The major phases of the steel design process can be defined as early design, design development, and connection detailing. Typically, the frame type (e.g., moment frame, braced frame) and general layout is defined during early design. The process of selecting member section types or "sizing" usually begins during early design and continues through design development. Finally, the connections between members are designed during the connection detailing phase [1]. Table 1 lists the design decisions that are typically made by project phase and the level of definition of the resulting structural design.

Design decisions made early in the process have a more significant impact on cost compared to later decisions. As shown in Figure 1, it is estimated that 37% of the total installed cost of a steel frame structure is determined during early design and that 63% of costs are determined by the completion of the design development phase [2].

In conventional practice, designers estimate the total installed cost of a steel frame structure during the early design and design development phases based on the weight of steel [1]. Weight therefore becomes a key metric by which design options are evaluated during these phases of the project. Skitmore and Ashworth define the weight-based estimate an approximate estimate since it relies on a single variable and note that additional variables are required to improve the accuracy of the estimate since the total installed cost of a steel frame

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