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Column Removal Analysis of Bare Steel Gravity Frames Using Connection Behaviour from Physical Tests

Steven A. Oosterhof

DIALOG, Edmonton, AB, Canada

David A. Nethercot

Imperial College London, London, United Kingdom

Robert G. Driver

University of Alberta, Edmonton, AB, Canada

Contact: David A. Nethercot (d.nethercot@imperial.ac.uk)

Abstract

This paper investigates the dynamic response of bare steel framing systems with commonly-used shear connections under several column removal scenarios. The analysis follows the Imperial College London method for progressive collapse assessment, which provides a simplified approach that accounts for the dynamic effects associated with instantaneous column removal and a practical framework for assessing the collapse resistance of a structure. Load–deformation relationships and failure limits for beam-to-column connections under combined moment, shear, and tension used for this study are taken directly from physical test data, providing realistic connection behaviour for the prediction and assessment of dynamic response. The robustness of various shear connections is quantified and compared, and connection parameters that significantly affect performance under dynamic loading are discussed.

Keywords: column removal; dynamic response; progressive collapse; robustness; steel structures; shear connections.

1. Introduction

The Imperial College London (ICL) method for progressive collapse assessment developed by Izzuddin et al. [1] provides a simplified approach to accounting for the dynamic effects associated with instantaneous column removal and a practical framework for assessing the collapse resistance of a structure. This study takes the load–deformation relationship and failure criterion of the beam-to-column connections under combined moment, shear, and tension—which are critical to the performance of the overall system, and to the implementation of the ICL method—directly from physical tests completed at the University of Alberta. Full details of the experimental program used for this analysis are reported by Oosterhof and Driver [2,3], including loading regime, specimen details, and characterization of behaviour. The tests include a series of full-scale steel beam-to-column shear connections under loading representative of column removal scenarios. Specimens tested include standard arrangements of shear tabs (ST), welded single angles (WA), and bolted single and double angles (SA and DA, respectively). Figure 1 shows the

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