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INVESTIGATION OF PRACTICAL GEOMETRIC NONLINEAR ANALYSIS METHODS FOR SEMI RIGID STEEL PLANE FRAMES

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Abstract

In this study, various practical geometric nonlinear analysis methods which encompass both the member stability (P-δ) and frame stability (P-Δ) are investigated for different types of semi rigid beam-to-column connections. Odd power polynomial function is used for the moment–rotation relationships and beam-to-column connections are modeled with rotational flexible springs. In order to capture the P-delta effects of ach beam-to-column connection, a numerical study of a six storey one bay steel plane frame is used and the results for lateral storey drifts, end moments are summarized in tables and graphics.

Keywords: *Geometric Nonlinear, Semi Rigid, Steel Frame*

1. INTRODUCTION

In conventional analysis and design of steel frame structures, the actual behavior of rigid beam-to-column connections is simplified by assuming each joint accommodates full transfer of moment, and the connection is assumed to rotate as a rigid body. In a pinned joint, the joint is assumed to act as a frictionless hinge connection with no moments acting at the joint. However, the actual behavior of most bolted, welded or a combination of bolted and welded connections used in steel frame structures are indeed semi rigid and are governed by a nonlinear relationship between the connection moment, and the relative rotation between the connected members [1]. The nonlinear behavior between beam-to-column connections is called as connection nonlinearity [2].

In structural analysis, there is also another type of nonlinear behavior for steel frames. If the equilibrium and kinematic relationships are written with respect to the undeformed geometry of the structure, the analysis is referred to as a first order analysis and when the deformed geometry of the structure is used, the analysis is referred to as a second order analysis, P-delta analysis or geometric nonlinear analysis [3]. In linear elastic analysis, solutions are obtained in direct manner but in geometric nonlinear analysis, since the deformed geometry of the structure is not known during the formulation of the equilibrium and kinematic relationships, solutions generally require an iterative type of procedure. The geometric nonlinear analysis usually proceeds in an incremental manner and the deformed geometry of the structure obtained from the previous cycle of calculations is used as basis in order to formulate the equilibrium and kinematic relationships for the current cycle of calculations [4].
In this paper, practical geometric nonlinear analysis methods are investigated with respect to P-Δ and P-δ effects, and the behavior is discussed for both perfectly rigid assumption and different types of semi rigid beam-to-column connections. Semi rigid connection types are modeled with odd power polynomial function method. Double web angles, header plate, top and seat angles and t-stub types of connections are used in the study for modeling different type of beam-to-column connections in order to capture the importance of connection types on the steel frame behavior.