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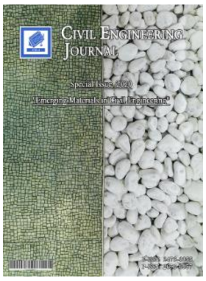
Civil Engineering Journal

Vol. 6, Special Issue "Emerging Materials in Civil Engineering", 2020



Pushover Response of Multi Degree of Freedom Steel Frames

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Received 11 September 2020; Accepted 03 December 2020

Abstract

Seismic codes use the behaviour factor to consider the ductility and the structure's non-linearity to improve the system's overall performance. Generally, Steel moment-resisting frames are characterized by a relatively high period showing high deformability and, foreseen that with stringent damageability criteria, the adopted behaviour factor might not optimally be utilized for achieving better performance of the frames. The design is generally governed by stiffness, leaving behind a complex structural system where the capacity design rules are disturbed and therefore necessitates to relax the drift limits for such frames. Given this and with extensive parametric analysis, the current paper aims to examine the behaviour factor of steel Moment Resisting Frames (MRFs). The parametric analysis has been conducted on rigid steel MRFs of 9, 7, and 5 storeys with bay 4 different bay widths of 9.15 m, 7.63 m, 6.54 m, and 5.08 m. Perimeter frame configuration has been designed using 4 different behaviour factors (q = 6.5, 4, 3, and 2) for a total number of 144 cases. Static nonlinear analysis has been conducted, and consequently, the behaviour factors have been examined. It has been observed that compatibility is required while choosing the drift limit for an assumed ductility class of the code.

Keywords: Parametric Analysis; Steel Structures; Seismic Codes; Damageability; Ductility Classes; Nonlinear Analysis.

1. Introduction

The empirical factors (response modification factor or behaviour factor) given by the seismic codes intend to account for the ductility of the structural system. The concept that well-detailed seismic framing systems could sustain large inelastic deformations (ductile behaviour) without collapse and dissipative zones must exhibit wide and stable hysteresis loops. Many codes, such as the National Building Code of Canada and the New Zealand Earthquake Load Standard, explicitly recognized reserve strength by providing an overstrength modification factor. Other codes, such as the ASCE, International Building Code, and Australian Earthquake Standard, use composite reduction factor to account for both overstrength and ductility. Many sources of overstrength can be easily identified, but not all can be readily quantified.

Many researchers investigated these factors, such as Uang (1991) [1], who established R (or Rw) and Cd factors for building seismic provisions. Humar and Rahgozar (2000) [2] assessed the extent of reserve strength attributable to redistribution in steel frames. Most recently, design procedure combining the benefits of the Performance-Based Plastic Design approach with a rigorous accounting of second-order effects is proposed in Dell'Aglio et al. (2019) study [3]. Kappos (1999) [4] studied the evaluation of behaviour factors based on ductility and overstrength. Balendra and Huang studied overstrength and ductility factors for steel frames designed according to BS 5950. Several researchers examined the force reduction factors, providing detailed discussions and improvements on the ductility reduction factors for example, Castiglioni and Zambrano (2010) used the damage accumulation approach to determine

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http://dx.doi.org/10.28991/cej-2020-SP(EMCE)-08