Available online at www.sciencedirect.com

ScienceDirect

Procedia Engineering 199 (2017) 397–403

Procedia Engineering

www.elsevier.com/locate/procedia

X International Conference on Structural Dynamics, EURODYN 2017

Evaluation of behaviour factors of steel moment-resisting frames using standard pushover method

Djamal Yahmi[a], Taïeb Branci[a,*], Abdelhamid Bouchaïr[b], Eric Fournely[b]

[a]*Departement of Civil Engineering, Hassiba Benbouali University of Chlef, Hai Es-Salem, Route de Sendjas, 02000 Chlef, Algeria*
[b]*Laboratory of Mechanic and Engineering, University Blaise Pascal, Clermont-Ferrand, 24 Avenue des Landais, 63170 Aubière, France*

Abstract

The structural performance limit (SPL) is an important parameter in the qualification of the behaviour factor (BF), because this factor is involved in the selection failure mode of the structure. EC8 does not indicate accurately criteria for define the failure mode or quantitative definition of the ultimate limit state corresponding to which values of BF frames are recommended. Moreover, the evaluation of the seismic strength of structures of buildings is usually carried out by the capacity design approach taking into account the nonlinear response of structure through the BF and in seismic design codes actual seismic load is reduced by this factor that takes into account several parameters including the capacity to dissipate energy, reserve strength and redundancy. Thus, the need for identifying BF in relation to its importance in the seismic design of frames seems indispensable. In this study, results of standard nonlinear static pushover analysis (NSPA) using SAP2000 program for steel moment-resisting frames (SMRFs) of different stories and bays were analyzed and compared and conclusions regard the effect of the structural performance limits and the capacity factor and other parameters on BF and its components are presented. It is found that the height and the capacity factor of frame have a profound effect on the BF and the value of this factor recommended by the EC8 is underestimated, mostly for low-rise frames.

Keywords: behaviour; ductility; redundancy; pushover; steel; frame; code.

1. Introduction

Currently, many seismic design codes, such as EC8 [1] and ASCE-7 [2], permit a reduction in design base shear force, taking advantage of the fact that the building structures possess significant reserve strength, redundancy,

* Corresponding author, *E-mail address:* t.branci@univhb-chlef.dz

1877-7058 © 2017 The Authors. Published by Elsevier Ltd.
Peer-review under responsibility of the organizing committee of EURODYN 2017.
10.1016/j.proeng.2017.09.130

damping and capacity to dissipate energy, which are incorporated in structural design through a reduction factor called behaviour factor (q-factor) in EC8 and response modification factor (R-factor) in the American codes. EC8 specifies a single value of behaviour factor for all building structures of a given framing type, irrespective of building dimensions (storie height and width bay). This approach, however, under certain circumstances may lead to values of the behaviour factor not always appropriate as compared with the actual dissipative features of the building structure [3-5]. The main aim of this study is to investigate the performance of medium ductile regular SMRFs designed in accordance with the provisions given in the European Codes EC3 [6] and EC8. In this context reserve strength, redundancy and ductility reduction factors are evaluated.

2. Methodology for computation of behaviour factor

The formula proposed by American codes for determining the BF is given by :

$$R = R_{\Omega} R_{\mu} R_{\rho} \tag{1}$$

where: R_{Ω}, R_{μ}, and R_{ρ}, are the strength reduction factor, the ductility reduction factor, and the redundancy reduction factor, respectively. The evaluation of these factors can be obtained from the capacity curve (Fig. 1).

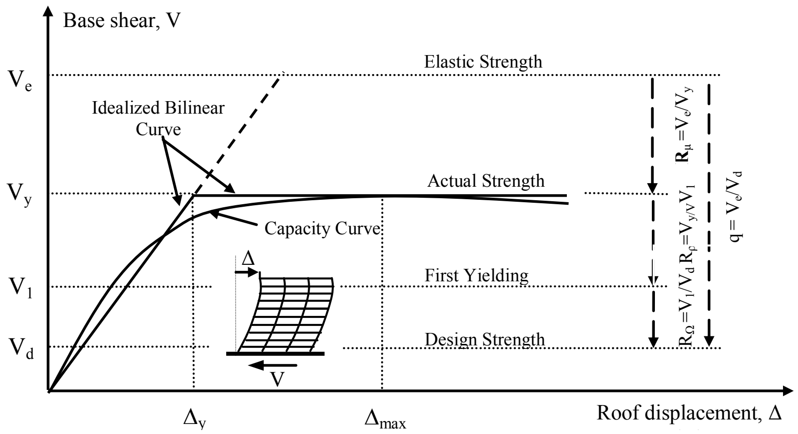

Fig. 1. capacity curve of a building structure (base shear versus roof displacement relationship).

In EC8 the BF for building structures is defined as follows:

$$q = q_0 \frac{\alpha_u}{\alpha_1} \tag{2}$$

where: q_0 is the basic value of the BF, α_u represents the horizontal force multiplier corresponding to the maximum lateral strength, and α_1 is the multiplier corresponding to the first yielding in the structure. From the comparison of equations (1) and (2), it follows that $\alpha_u/\alpha_1 = R_\rho$ and $q_0 = R_\mu R_\Omega$ [4].

3. Considered parameters

Several parameters, such as the number of stories and bays, the structural performance limits and the capacity factor "Column/Beam (a_i)", are considered to see how they affect the BF and its components. The capacity factor, α_i, is given by :