Available online at www.CivileJournal.org

Civil Engineering Journal

Vol. 5, No. 12, December, 2019

An Investigation of the Fundamental Period of Vibration for Moment Resisting Concrete Frames

Ahmed N. Mohamed [a*], Khaled F. El Kashif [b], Hamed M. Salem [c]

[a] *M.Sc. Student, Structural Engineering Department, Cairo University, Giza, Egypt.*

[b] *Assistant Professor, Structural Engineering Department, Cairo University, Giza, Egypt.*

[c] *Professor, Structural Engineering Department, Cairo University, Giza, Egypt*

Received 24 May 2019; Accepted 30 September 2019

Abstract

The determination of fundamental period of vibration for structures is essential to earthquake design. The current codes provide empirical formulas to estimate the approximated fundamental period and these formulas are dependent on building material, height of structure or number of stories. Such a formulation is excessively conservative and unable to account for other parameters such as: length to width ratios, vertical element size and floors area. This study investigated the fundamental periods of mid-rise reinforced concrete moment resisting frames. A total of 13 moment resisting frames were analyzed by ETABS 15.2.2, for gross and cracked eigenvalue analysis and Extreme Loading for Structures Software® or ELS, for non-linear dynamic analysis. The estimated periods of vibration were compared with empirical equations, including current code equations. As expected, the results show that building periods estimated based on simple equations provided by earthquake design codes in Europe (EC8) and America (UBC97 and ASCE 7-10) are significantly smaller than the periods computed using nonlinear dynamic analysis. Based on the results obtained from the analyzed models, equations for calculating period of vibration are proposed. These proposed equations will allow design engineers to quickly and accurately estimate the fundamental period of moment resisting frames with taking different length to width ratios, vertical element size, floors area and building height into account. The interaction between reduction factor and the reduced period of vibration is studied, and it is found that values of maximum period of vibration can be used as an alternative method to calculate the inelastic base shear value without taking reduction factors in consideration.

Keywords: Fundamental Period of Vibration; Moment Resisting Frames; Stiffness and Mass of Building.

1. Introduction

Determination of fundamental period is essential to earthquake design and assessment. The accurate estimation for this property will improve the estimation of global seismic demands. Since this property is dependent on mass and stiffness, it is affected by many factors such as building material, structural regularity, the number of stories and bays and the section properties including dimensions and extent of cracking. Cracking of RC members decreases its stiffness significantly and so this reduction should be considered in analysis to determine the expected period of vibration.

As this property cannot be analytically computed for a structure before design process, building codes provide empirical formulas that is depend on material, steel or concrete, and height of structure or number of stories. It is also allowed using finite element with assumed mass and stiffness to determine this property during the preliminary design stage and limit the estimated period with an upper bound factor.

* Corresponding author: ahmednader727@gmail.com

http://dx.doi.org/10.28991/cej-2019-03091438