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Introducing a simple shear building model for eccentrically braced frames

Reza Karami Mohammadi[1], Zahra Sadat Moussavi Nadoushani[2]

1- Assistant Professor, K.N. Toosi University of Technology
2- M.Sc., K.N. Toosi University of Technology

rkarami@kntu.ac.ir

Abstract

Lateral stiffness of eccentrically braced frames (EBF) is vital in computing story drifts. it is composed of flexural, shear, and axial stiffness of various members of the frame. In this paper a new shear building model is used which have the same equivalent lateral stiffness as the assumed EBF in each story. This shear building model can facilitate non-linear time history analyses and is almost the same accurate as a detailed model of EBF. The accuracy of this shear building model is verified by pushover and Incremental Dynamic Analysis (IDA). For this purpose, different EBFs and their equivalent shear buildings are modeled and designed; the maximum inter-story drifts and roof displacements of both EBFs and shear building models are computed by IDA analyses for 19 different records and compared. The results show appropriate consistency between the response of introduced shear building models and corresponding EBFs in nonlinear time-history analyses.

Keywords: Eccentrically Braced Frame, Shear-Building Model, Incremental Dynamic Analysis, Nonlinear Behavior

1. INTRODUCTION

Steel eccentrically braced frame, EBF, is an effective alternative to moment frame and concentrically braced frame. It combines the high stiffness of concentrically braced frame with the high ductility and energy dissipation of moment resisting frame. In this type of frame the braces are offset from each other or from beam-column connection by a distance “e” that is called as the link-beam. The successful performance of EBFs under seismic loading depends on the fuse action of the link which is designed whereby becoming active and developing yielding during seismic overloading while the other components of the frame remain elastic. Thus the inelastic response of EBFs is dominated by the behavior of its active links [1].
Estimating the lateral force-deformation behavior of EBFs is important in computing story drifts and link rotations which are fundamental parameters in performance-based design analysis and have prescribed limits. This behavior can be divided into the elastic and the inelastic parts.
Many experimental and analytical studies were carried out to determine the elastic and inelastic behavior of EBFs. The elastic displacement of an EBF can be calculated by summing the displacements caused by the deformations of each components of the frame [2]. These main displacements are due to the braces axial deformation, the beam axial deformation, the link shear deformation and beam and link flexural deformations [3]. The formulation of these displacements and the prediction of the story displacement at yield level will be discussed in the next sections.
Researchers have developed some link-beam models for static and dynamic inelastic analysis of EBFs. In these studies links are modeled as a linear beam element with concentrated nonlinear flexural and shear hinges at their ends and the strain hardening is included. The multi-linear function that describes the inelastic behavior of global end hinges is obtained by dividing them into series of sub-hinges [1] or by introducing rotational and translational spring elements [4]. These analytical models show very good agreement in predicting the maximum shear forces and deformations when compared with the latest experimental data on shear links [5].
In this paper a new shear building model is used which have the same equivalent lateral stiffness and hysteretic force-deformation behavior as the assumed EBF in each story. Making non-linear time history analyses easier, this shear building could be almost as accurate as a complex finite element model. Detailed models are sometimes so sophisticated that augment the nonlinear time history analysis duration, so it is useful to have a simpler model to facilitate this analysis. The accuracy of this shear building model is also