ON THE IMPROVEMENT OF NONLINEARSTATIC PROCEDURES FOR STRUCTURES SUBJECTED TO NEAR-FAULTGROUNDMOTIONS CONSIDERINGVARIOUS FAULTING MECHANISMS

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ABSTRACT

This paper investigates inelastic seismic demands of the normal component of near-fault (NF) pulse-like ground motions, which differ considerably from those of far-fault (FF) ground motions and also parallel component of near-fault ones. The results are utilized to improve the nonlinear static procedure (NSP) called Displacement Coefficient Method (DCM). 96 NF and 20 FF ground motions and the responses of various SDOF systems constitute the dataset. A comprehensive set of Nonlinear Time-history (NTH) analyses are conducted to produce benchmark responses against the predictions of NSPs are compared. Considerable influences of different faulting mechanisms are observed on inelastic seismic demands. The demands are functions of the strength ratio and also the ratio of pulse period to structural period. Simple mathematical expressions are developed to consider the effects of NF motion and fault type on nonlinear responses. Modifications are presented for the DCM by introducing a NF modification factor, C_N. In locations, where the fault type is known, the modifications proposed in this paper help to obtain a more precise estimate of seismic demands in structures. The second objective is the verification of the probable differences in seismic demands of MDOF structures, including steel moment-resisting frames, and also inefficiencies of current lateral load patterns. The family of structural models used in this study is composed of nine and twenty-story 2-D moment resisting steel frames, considering medium to tall frame models. Two basic types of ground motions are used as the input: 10 FF and 10 NF ground motions. NTH analyses as the output, which are utilized to demonstrate the differences in seismic demands for each set, including interstory drift ratios and peak roof displacement ratios.

INTRODUCTION

Performance-based engineering methods that rely on NSPs for prediction of structural demands have been introduced in recent decades. FEMA 440 (2005) presents the results of a comprehensive study on this subject. This document reviews the related documents, namely FEMA 356 (2000) and ATC-40 (1996), and proposes improvements in calculating the inelastic displacement demand for a given ground motion. FEMA 440 includes descriptions of the two NSPs that were recommended by above-mentioned codes and used in practice. FEMA 356 utilized DCM, in which several empirically derived factors were used to modify the response of an elastic SDOF model of the structure to account for inelastic effects. The alternative Capacity Spectrum Method (CSM) of ATC-40 used empirically derived relationships for the effective period and damping as a function of ductility to estimate the response of an equivalent linear SDOF oscillator in an iterative procedure. Recommendations of FEMA 440 have been implemented in some recent codes of practice such as ASCE41-06 (2007). Approximate NSPs are commonly used in engineering practice as an