9th International Congress on Civil Engineering, May 8-10, 2012
Isfahan University of Technology (IUT), Isfahan, Iran

Genetic Programming Approach for Prediction of Maximum Displacement Profiles of Plane Steel Moment Resisting Frames

Nadia M.Mirzai[1], Hamed Saffari[2], Iman Mansouri[3]

1- Department of Civil Engineering, Shiraz University, Shiraz, Iran
2,3- Department of Civil Engineering, Shahid Bahonar University of Kerman, Kerman, Iran

nmirzai@shirazu.ac.ir

Abstract

This paper summarizes the results of an extensive study on the seismic response of plane steel Moment Resisting Frames (MRFs). A new relation to estimate maximum seismic displacement profiles of plane steel Moment Resisting Frames are proposed using genetic programming (GP) approach. This expression is obtained via a statistical analysis on the results of many hundreds of nonlinear dynamic analyses. The influence of specific parameters is studied in detail. The OpenSees program is adopted for performing the nonlinear dynamic analyses of this paper. A comparison of the proposed method with the procedures adopted in current seismic design codes reveals the accuracy and efficiency of the former.
Keywords: Genetic programming, Displacement profile, Dynamic analysis, Steel frames.

1. INTRODUCTION

In general, performance-based seismic engineering (PBSE) relies in the identification of structural performance based on limits states. At the same time, limit states are based on deformation quantities such as drift or displacement. The definition of limit states related to any of these deformation quantities is paramount in the performance-based seismic design. Also, the relationship of these deformation quantities with typical variables found at the outset of the design process such as axial load and aspect ratio become very important in this type of design approach. As a result of the introduction of PBSE it has become imperative that a seismic engineering methodology be capable of producing a system that can achieve a desired performance objective. In the past decade researchers have worked on adopting various methodologies to meet this need. These methods include: (1) Force-Based Design (FBD); (2) Displacement-Based Design (DBD); and (3) Energy-Based Design (EBD).

Actually, each limit state in DBD is defined by converting damage levels to displacement levels [1]. This is achieved by utilizing a simple relation that correlates a damage index, such as the interstory drift ratio (IDR), with the maximum floor displacements of the building. Those displacements constitute the maximum displacement profile, which has a significant impact on the final result of the DBD method.

In general, the research efforts for estimating maximum displacements of multi degree of freedom (MDOF) building structures have focused on procedures which use equivalent single degree of freedom systems (SDOF). The mechanical characteristics of the SDOF system are established by using the results of a pushover analysis of the corresponding MDOF system in the form of a plot of base shear versus top displacement [2].

Genetic programming (GP) is a new technique used in civil engineering. Only a few applications of GP fall into the field of civil engineering. Chen [3] applied GP to estimate concrete strength. Asadi et al. [4] proposed a new formulation for strength of intact rocks through genetic programming. Savic et. al [5], Whigham and Crapper [6], and Keijzer and Babovic [7] applied GP to rainfall-runoff modeling. Raju and Kumar [8] investigated irrigation planning using genetic algorithms. Dorado et al. [9] studied prediction and modeling of the rainfall-runoff transformation of a typical urban basin using artificial neural networks (ANNs) and GP. Rabunal et al. [10] determined the unit hydrograph of a typical urban basin using GP and ANNs. Giustolisi [11] proposed the resistance coefficient in corrugated channels by using GP.

GP has a structure where nonlinear functions are present and the parameter identification process is based on techniques that search for global maxima in the space of feasible parameter values [12]. Thus, GP can denote the nonlinear effects present in the scour process. Non-stationary effects present in global phenomena morphological changes in rivers can be captured by inner structure of GP. All these features of GP make it an effective tool in the formulation of displacement of structures.