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IDENTIFICATION OF HYSTERICALLY DEGRADING STRUCTURES USING BWBN MODEL

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ABSTRACT

Structural control and health monitoring scheme are playing a key role not only to enhance life safety for infrastructure systems but also to optimally minimize the life cycle cost and maximize the performance through the full life cycle design under natural disasters. In this paper, first, characteristics of Bouc-Wen-Baber-Noori model is presented, subsequently, we analyze a three story shear structure subjected to sine wave by using Intelligent Parameter Varying approach, Genetic Algorithm and Transitional Markov Chain Monte Carlo method. Correlation study is made to compare the system identification results.

Keywords: hysteretic behavior, BWBN model, Intelligent Parameter Varying, Genetic algorithm, Transitional MCMC.

INTRODUCTION

Under cyclic loading, mechanical or structural systems may dissipate considerable energy through hysteretic behavior. A few examples of Bouc-Wen-Baber-Noori (BWBN) general hysteresis models have been studied (Dobson, 1997, Zhang, 2002). An intelligent parameter varying approach (IPV) proposed by (Saadat 2007) to overcome the limitations of traditional system identification techniques is utilized herein to identify the system parameters of a BWBN system. A shear structure with BWBN hysteretic restoring force is subjected to ambient sinusoidal wave and the implication of the parameters of the model is carried out.

$$m\ddot{x} + c\dot{x} + R = F(t) \tag{1}$$

$$m\ddot{x} + c\dot{x} + R = F(t) \tag{2}$$

$$\dot{z} = \frac{A\dot{x}_1 - \nu[\beta|\dot{x}_1||z|^{n-1}z + \gamma\dot{x}_1|z|^n]}{\eta} \tag{3}$$

$$\dot{x}_2 = \sqrt{\frac{2}{\pi}}\frac{s}{\sigma}exp\left[-\frac{z^2}{2\sigma^2}\right]\dot{z} \tag{4}$$

$$\dot{\varepsilon} = (1-\alpha)k\dot{x}z \tag{5}$$

$$s = \delta_s\varepsilon \tag{6}$$

The structure is composed of three lumped mass subsystems, where each subsystem (floor m_i) only moves laterally, and the structural restoring force R_i between the adjacent floors is modeled by incorporating a BWBN hysteresis model. In this study, for system identification, an Intelligent Parameter Varying (IPV) technique, with embedded radial basis function

networks are used to estimate the constitutive characteristics of hysteretic restoring forces. This approach is then compared with the results using a genetic algorithm (Charalampakis, 2010). and a Transitional Markov Chain Monte Carlo (TMCM) approach (Zhang, 2001).

RESULTS AND CONCLUSIONS

Due to space limitation only the tables summarizing the correlation coefficient analyses are presented. Table 1 shows the simulated response of the IPV based model approximates the true response of the hysteretic structural system subjected to sinusoid input and the system identification results show that the correlation coefficients are 1.

Table 1 - Correlation Coefficient Analysis for IPV

CR-t3	CR-t2	CR-t1	CR-x3	CR-x2	CR-x1
1.0000	1.0000	1.0000	1.0000	1.0000	1.0000

The correlation coefficient results using genetic algorithm are shown in Table 2. The results show that the correlation coefficients approach 1, especially for the first floor of the hysteretic structure subjected to sinusoid input.

Table 2 - Correlation Coefficient Analysis

CRt3	CRt2	CRt1	CRx3	CRx2	CRx1
0.9546	0.9770	0.9829	0.9546	0.9770	0.9829

The correlation coefficients for TMCM using a Bayesian inference framework are shown in Table 3. We can see that the correlation coefficients approach 1 and the system identification result is relatively accurate.

Table3 - Correlation Coefficient Analysis

CR-t3	CR-t2	CR-t1	CR-x3	CR-x2	CR-x1
0.9925	0.9932	0.9957	0.9925	0.9932	0.9957

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