Iranian Journal of Science & Technology, Transaction B, Engineering, Vol. 32, No. B5, pp 471-490
Printed in The Islamic Republic of Iran, 2008

MODIFIED NON-STATIONARY CRITICAL INPUT EXCITATION BY A DESIGN ORIENTED OBJECTIVE FUNCTION*

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Abstract– Nowadays, seismic design of structures performed by any seismic code is based on resisting previous natural earthquakes. Therefore, the critical excitation method has been proposed in recent years to consider probable future earthquakes that may be more destructive. Non-stationary critical excitation for a structure is found under specified constraints to resonate the structure. In this paper, the objective function of non-stationary critical excitation is taken as the maximization of all the inter-storey drifts at different times, separately. The power (area under power spectral density function) and the intensity (magnitude of PSD function) are limited, and critical excitation is found according to these constraints. Three techniques of finding non-stationary critical excitation are proposed, *optimum line*, *simple* and *modified* techniques. Then, the proposed techniques are used in many MDOF models and the results are investigated.

Keywords– Critical excitation, non-stationary input, optimization, random vibration, design

1. INTRODUCTION

Earthquake is an uncertain and unpredictable phenomena and it is always possible for a more destructive earthquake to occur in the future. Therefore, seismic design of structures based only on withstanding previous earthquakes seems to be inadequate. However, static and modal seismic designs of structures are based on the design spectrum produced by previous earthquakes. In addition, time-history analysis of structures applies previous accelerograms.

For the first time, A. Papoulis [1] introduced the critical excitation concept in electrical engineering in 1967. Then, R.F. Drenick [2] used the method of critical excitation for structures in time domain. In this method, an input excitation is obtained which produces the maximum response from a class of allowable inputs. In addition, M. Shinozuka [3] expressed the same method in the frequency domain and presented a narrower upper bound of the maximum response.

Critical excitation method is an optimization problem to be solved having an objective function and constraints. Until now, many people have worked on different constraints and objective functions. Iyengar, Manohar, Sarkar and Takewaki are researchers who extended the method to a stochastic problem to consider the uncertain characteristics of an earthquake [4-9]. Also, Ben-Haim, Elishakoff, Pantelides and Tzan presented several interesting convex models [10, 11]. Critical excitation method produces artificial earthquakes that have greater responses than other artificial record generation methods using wavelet theory [12] and random and geophysics models [13].

Recently, Takewaki [8] has developed a new optimization problem in frequency domain for finding non-stationary input excitation. His proposed constraints were the power limit (area under power spectral density (PSD) function) and the intensity limit (magnitude of PSD function). Solving this nonlinear

*Received by the editors January 31, 2007; Accepted December 2, 2007.
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