EVALUATION OF ADAPTIVE PUSHOVER METHODS IN STRUCTURES WITH VERTICAL STRENGTH IRREGULARITIES

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In recent years, many studies have been performed to develop and improve various methods for performance evaluation of structures. One of the most practical tools for this purpose is nonlinear static analysis procedure or so called pushover analysis. Nonlinear static procedures (Push Over) have attracted special attention of researchers due to simplicity of implementation (Chopra, 2002) and ease of results interpretation. The main disadvantage of the common nonlinear static procedures in the current Codes and regulations is that a constant lateral load pattern is applied during the analysis and the changes in the modal characteristics of the structure due nonlinear behavior cannot be applied. Another disadvantage of these methods is their weakness in performance evaluation of irregular structures. In these structures the estimation of nonlinear static procedures experiences meaningful errors and diverge from the result of more exact procedures such as nonlinear dynamic analysis. To overcome such a disadvantage, Adaptive Push over Procedure has been introduced by a number of researchers in recent years. In this procedure, lateral load pattern is changed in accordance with the instant stiffness matrix (Gupta and Kunnath, 2000).

In this study the ability of this method on performance evaluation of irregular building in height was examined. Different nonlinear static procedures are evaluated by applying constant and adaptive loading patterns on 20-story steel moment frames irregular in height. Seismic demands obtained from nonlinear static procedures were compared with exact results obtained from the nonlinear time history dynamic analysis. The results indicated (Figure 1) that among chosen method, Shear-based Adaptive Procedure (SAP) has the best performance in predicting the seismic demands among other Adaptive Procedures in performance evaluation of irregular buildings.

Push Over methods in this study were classified into two groups of constant load pattern and adaptive load pattern. In the first group, the lateral load patterns corresponding to the Mode 1, Rectangular, Inverted Triangular and Code lateral load distributions were used (Equation 1).

$$c_{vx} = \frac{w_x h_x^k}{\sum_{i=1}^{n} w_i h_i^k} \qquad (1)$$

where i is number of the floors, Wi and Wx are weights of the i*th* and x*th* floors, hi and hx are heights of i*th* and x*th* floors, and n is number of the floors. The value of k was obtained using equation (2):

$$K=0.5T+ 0.75 \qquad (2)$$

For periods less than 0.5 seconds and more than 2.5 seconds, k is equal to 1 and 2, respectively (FEMA 2005).

In the second group, Push Over methods with Adaptive load pattern based on the force, drift of the floors, Mode 1 of the structure, and also floor shear were used.

Figure 1 shows the average drift error for the studied structures. As it can be seen from the figure, Code method is the most accurate method. In SM (1) * 1.35 and SM (10) * 1.35 models, all the methods except Code method estimated the drift of the floors with less error in comparison to Base model. In SM (1-9.11-20) * 1.35 model, all the methods estimated the drift of the floors with a higher error value than Base method. But in SM (2-20) * 1.35 model, with a weak first floor, all the methods except FAP and Code methods estimated the drift of the floors with higher error values than Base method. Among all the adaptive methods, SAP method has the best performance for all the structures, with a maximum error of 37.81%. Rectangular method has the worst performance with a maximum error of 52.26% for SM (1-9.11-20) * 1.35 model.

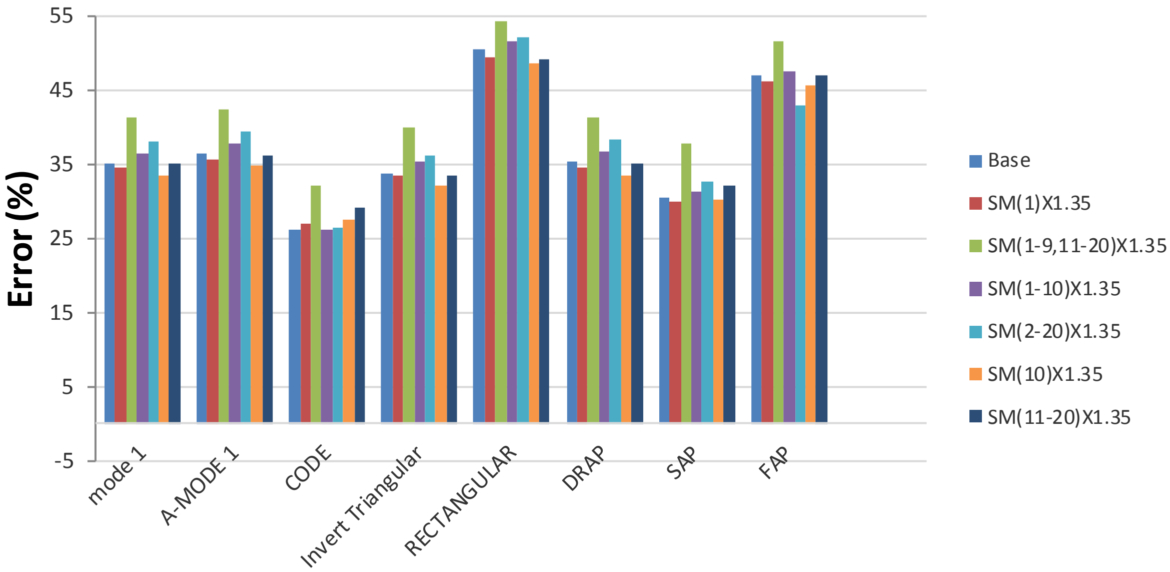

Figure 1. Mean error of interstorey drift

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