SYSTEM IDENTIFICATION ON SEISMIC RESPONSE OF BUILDING STRUCTURE

Chin-Hsiung Loh

Department of Civil Engineering
National Taiwan University

ABSTRACT

In the field of earthquake engineering, analytical modelling of structures subjected to ground motions is an important aspect of fully dynamic earthquake-resistant design. In general, linear models are only sufficient to represent structural responses resulting from earthquake motions of small amplitudes. Howener, the response of structures during strong ground motions is highly nonlinear and hysteretic, and the use of system identification techniques for damage evaluation is an important problem. This paper explores the potentials of a new time-domain identification procedure to detect the changes of structural dynamic characteristics on the basis of measurements. The experiment involves the computer simulation of seismic responses of two steel frames with and without evergy dissipation devices. First , the recursive instrumental variable method is used to explore the response indices of linear/equivalent linear system. The indices include mode shapes, story drift and base shear distribution. The sweep model identification procedure is used to identify the modal parameters from lower mode to higher mode (assumed modal interference was insignificant). Comparison on the identified response indices between weak motion and strong motion are made. Through the identified response indices the inelastic behavior of structure ressponse can be observed. Finally, the extended Kalman filter technique is adopted to identify the nonlinear charactoristics of building responses.

Drain-2D inelastic plane structural analysis was performed on two-prototype 8-Story steel structures. One of the building was put energy dissipation devices at 1-st and 5-th floors, as shown in Figure 1. The scaled El Centro acceleration record with different intensity levels (from 100 gal to 300 gal) were specified as input ground motions. Figure 2 shows the comparison between the identified mode shapes and story

drift from the response data when different input intensity is specified. It is found that the identified mode shapes can not provide information to judge the nonlinear response of structure, but the story drift provides significant differences when the input intensity are different. It is clear that through linear analysis the dynamic characteristics and response indices of structural system can be observed. Nonlinear system identification was used to identify the nonlinear model parameters from strong motion data. Figure 3 shows the hysteresis loop between the floor response of 6th and 7th floor as well as the comparison of displacement response between simulation and identification. Since the results are generated under the assumption of linear system, and to have a better result nonlinear model must be included. Figure 4 shows the comparison between the simulated and the identified 5th floor response as well as the identified model parameters. using Bouc-Wen nonlinear model.

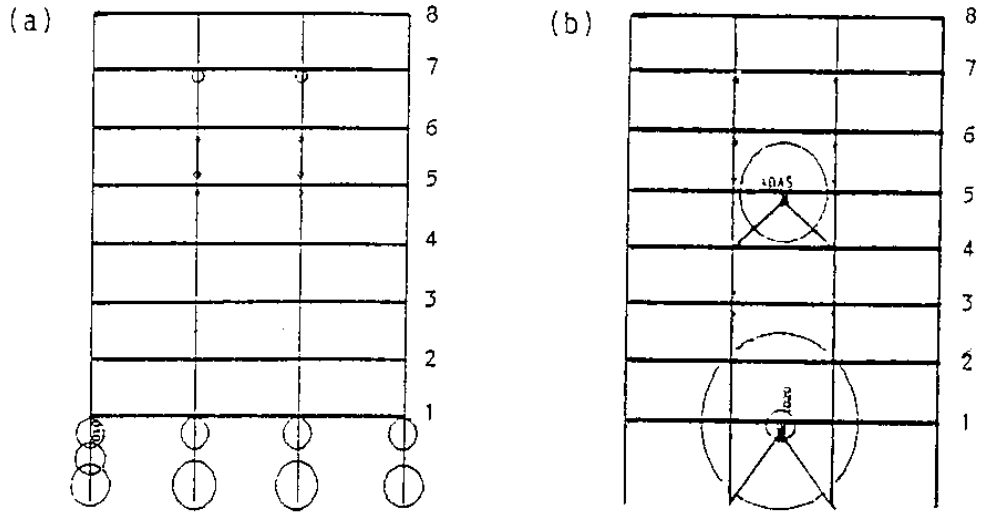


Fig.1: Geometry of 8-story steel frames without (Fig.1a) and with (Fig.1b) energy dissipation devices. The angle of rotation during ground motion at column is also shown by circle(as compare to the standrad circle)

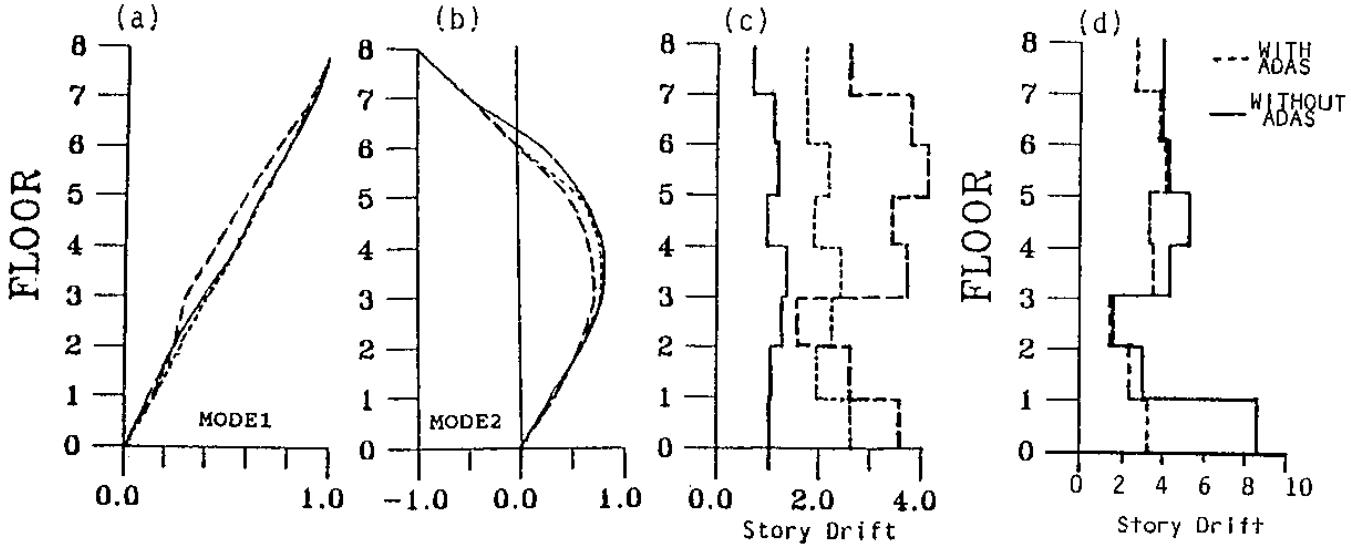


Fig.2: Comparison between the identified mode shapes and story drift from data under different PGA input intensity (—— 100 gal; --- 200 gal, —— 300 gal). Fig.2d shows the comparison on story drife between two structures (with and without energy devices).

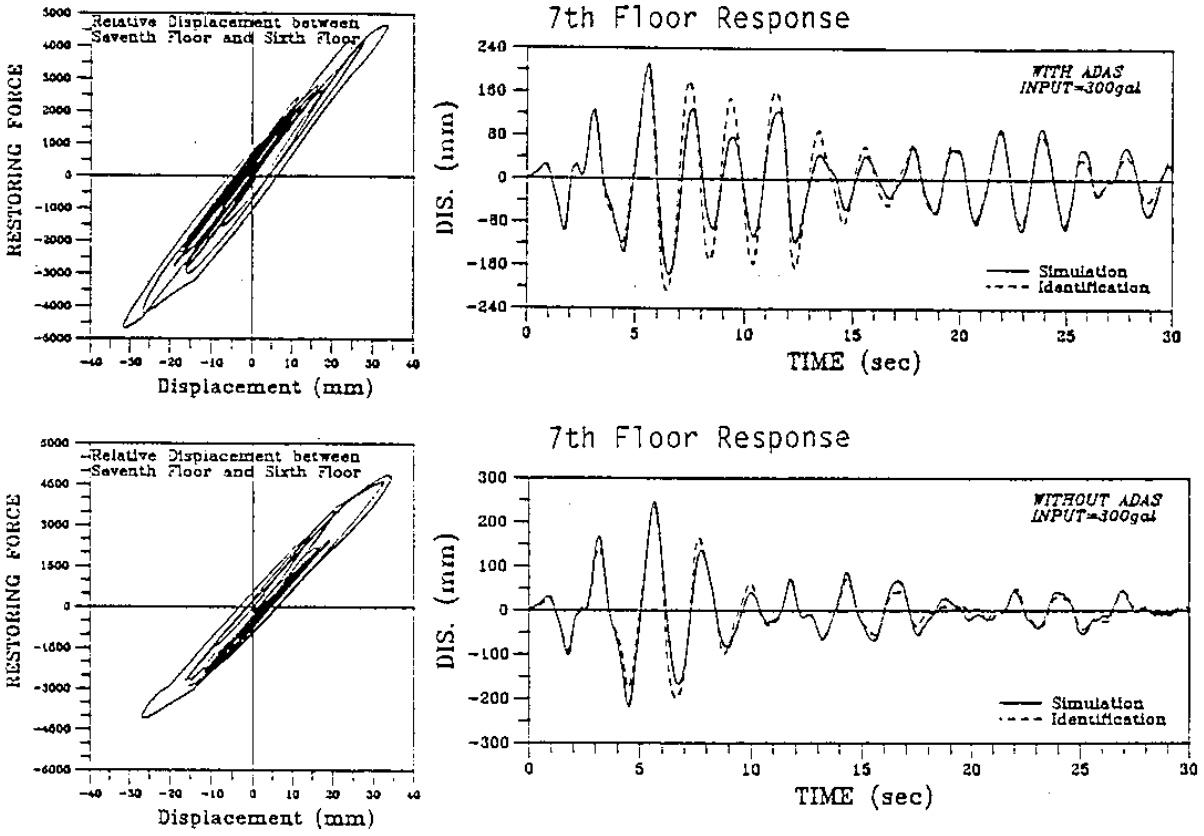
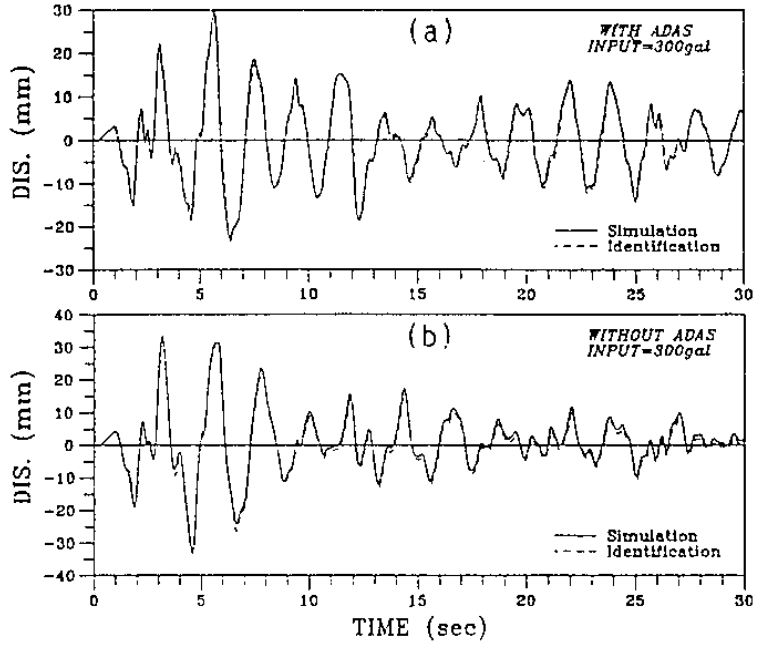
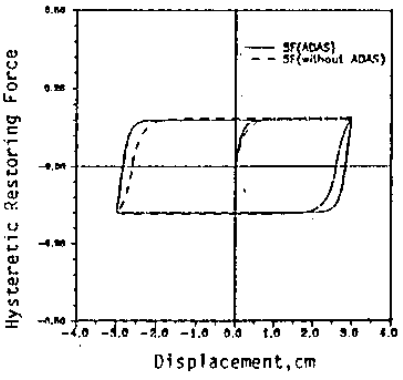


Fig.3: Plot of restoring force diagram (recorded) and the comparison on the time response (recorded vs estimated) at 7-th floor for system with and without energy dissipation devices. Assuption on linear model was made in the identification.



(c)



	Identified Model Parameters				
	α	A	β	γ	n
With ADAS	0.595	1.0	3.926	4.358	1.112
WITHOUT ADAS	0.806	1.0	0.277	2.613	0.577

Fig.4 Comparison between the simulated and identified 5th floor displacement response for system,(a) with energy dissipation devices, (b) without energy dissipation devices. The identified model parameters of hysteretic restoring force is also shown in figure 4(c).