EFFICIENCY ASSESSMENT OF SCALAR INTENSITY MEASURES IN PREDICTING ENGINEERING DEMAND PARAMETERS

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How to select strong ground motion records as input of the nonlinear time history analysis (NLTHA) is an important challenge because of its significant influence on the output of analysis. Due to the unpredictable nature of earthquake ground motions, to achieve a reliable result, we should either use a large set of recorded ground motion, which can be time consuming, or to find a new method that help us to achieve the results with the same level of reliability, but with reduced number of records. As strong ground motion intensity measures (IM) are effective parameters affecting the results of nonlinear time history analysis, several methods have been proposed to select and scale records using one or more IMs.

Shome et al. (1998) showed that halving the dispersion in ground-motion intensities decreases the necessary number of NLTHA by a factor of 4 keeping the same level of dispersion in estimated engineering demand parameters (EDP). In 2006, Baker and Cornell proposed $\varepsilon_{SA(T1)}$ as a new IM that can be an indicator of spectral shape which is an important effective parameter in NLTHA. Mousavi et al. (2011) showed that the correlation between $\varepsilon_{SA(T1)}$ and nonlinear time history responses is strong enough that using of ε-filtration in selection of GMRs results reduction of bias in the prediction of the structural nonlinear responses.

Due to the fact that capability of different IMs in predicting nonlinear responses are not equal and relates to the correlations between these parameters and desired EDPs in case of a specific structure, efficiency assessment of some scalar IMs is investigated in this paper. For this purpose, NLTHA performed in a 3-story 3-D steel moment frame by using a set of records selected considering the spectral shape. Scaling methods are by: PGA, S_A(T1) and code based. These records selected from the PEER NGA database and are listed in Table (1).

Maximum interstory drift ratio, base shear and base moment are the EDPs used in this paper to compare the efficiency of scaling methods. Table (2) presents the calculated correlations between these parameters and scalar IMs.

The results illustrate that, the influence of velocity Spectrum Intensity is more than other intensity measures, in conclusion, use of this parameter in selection and scaling procedure can reduce the dispersion of NLTHA.

Table 1. Ground motion set selected from the PEER NGA database

Event	Year	Station	Mag	R_{jb}(km)	R_{rup}(km)	Vs_{30}(m/s)
Chi-Chi, Taiwan	1999	CHY029	7.62	11	11	544.7
Chi-Chi, Taiwan	1999	CHY034	7.62	14.8	14.8	378.8
Chi-Chi, Taiwan	1999	CHY035	7.62	12.6	12.7	555.2
Chi-Chi, Taiwan	1999	TCU116	7.62	12.4	12.4	493.1
Chi-Chi, Taiwan	1999	TCU042	7.62	26.3	26.3	424
Chi-Chi, Taiwan	1999	TCU070	7.62	19	19	401.3
Northridge-01	1994	LA - UCLA Grounds	6.69	13.8	22.5	398.4
Northridge-01	1994	LA - Wadsworth VA Hospital North	6.69	14.6	23.6	392.2
Northridge-01	1994	LA - Wadsworth VA Hospital South	6.69	14.6	23.6	413.8
Loma Prieta	1989	Coyote Lake Dam (SW Abut)	6.93	20	20.3	597.1
Loma Prieta	1989	Palo Alto - SLAC Lab	6.93	30.6	30.9	425.3
Loma Prieta	1989	WAHO	6.93	11	17.5	376.1
Hector Mine	1999	Hector	7.13	10.3	11.7	684.9
Landers	1992	Joshua Tree	7.28	11	11	379.3
Irpinia, Italy-01	1980	Calitri	6.9	13.3	17.6	600

Table 2. Correlation factor between engineering demand parameters and scalar IMs

Intensity Measures	Correlation factor between EDP and scalar IMs		
	MIDR	Base shear	Base moment
Max. Acceleration (g)	0.19	0.24	0.09
Max. Velocity (cm/sec)	0.59	0.64	0.38
Max. Displacement (cm)	0.19	0.38	0.08
Vmax / Amax: (sec)	0.38	0.38	0.30
Acceleration RMS: (g)	0.19	0.39	0.19
Velocity RMS: (cm/sec)	0.38	0.68	0.34
Displacement RMS: (cm)	0.18	0.39	0.07
Arias Intensity: (m/sec)	0.35	0.51	0.22
Characteristic Intensity (Ic)	0.31	0.50	0.24
Specific Energy Density (cm^2/sec)	0.22	0.41	0.10
Cumulative Absolute Velocity (cm/sec)	0.41	0.58	0.33
Acceleration Spectrum Intensity (g*sec)	0.29	0.42	0.23
Velocity Spectrum Intensity (cm)	0.84	0.79	0.66
Housner Intensity (cm)	0.79	0.77	0.64
Sustained Maximum Acceleration (g)	0.30	0.37	0.14
Sustained Maximum Velocity (cm/sec)	0.47	0.63	0.29
A95 parameter (g)	0.19	0.24	0.09
Predominant Period (sec)	0.22	-0.01	0.01
Mean Period (sec)	0.46	0.35	0.49
S_A(T1)	0.72	0.55	0.58

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