A GROUND MOTION PREDICTION EQUATION FOR CAV IN ZAGROS

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PGA, PGV and response spectral ordinates are well-known ground motion parameters which are widely used in attenuation and seismic hazard studies. These parameters only describe the amplitude of ground shaking caused by an earthquake. Apart from amplitude, duration is also important for distinguishing between destructive and non-destructive impact of an earthquake record. Cumulative Absolute Velocity (CAV), as a ground motion parameter, contains both of duration and amplitude effects of a strong motion record.

CAV is first introduced by EPRI in 1988 by integration of an absolute acceleration time series over whole of the record, denoted herein as CAV_{Total} (Equation 1).

$$CAV_{Total} = \int_0^{t\,max} |a(t)|\,dt \tag{1}$$

EPRI (1991) introduced a standardized definition of CAV to serve as a threshold for shutting the nuclear power plants down in case of disastrous earthquakes. Equation 2 shows the standardized version of CAV:

$$CAV_{STD} = \sum_{i=1}^{N} H\left((PGA_i - 0.025)\int_{i-1}^{i} |a(t)|\,dt\right) \tag{2}$$

where N is number of the 1 second time intervals, PGA_i, is the value of peak ground acceleration (g) in time interval i and $H(x)$ is the Heaviside Step Function presented in Equation 3:

$$H(x) = \begin{cases} 0 \rightarrow x < 0 \\ 1 \rightarrow x \geq 1 \end{cases} \tag{3}$$

Lastly, Kramer and Mitchel 2005 proposed a new version of CAV called CAV_5 and demonstrated that it has a closer relationship to pore-pressure generation in comparison to PGA and Arias Intensity. As a result, they suggested the use of CAV_5 as a measure for soil liquefaction. CAV_5 could be determined from Equation 4:

$$CAV_5 = \int_0^{\infty} \langle x \rangle |a(t)|\,dt \tag{4}$$

The $\langle x \rangle$ function is shown in Equation 5:

$$\langle x \rangle = \begin{cases} 0 \rightarrow |a(t)| < 0.005g \\ 1 \rightarrow |a(t)| \geq 0.005g \end{cases} \tag{5}$$

We have used 320 three component strong motion records registered in Zagros in order to derive a Ground Motion Prediction Equation (GMPE) for the three versions of CAV. The hypocentral distance is used as an independent variable ranging between 10 to 200 km. Moment magnitude of utilized events varies from 5.0 to 6.1 (Figure 1).

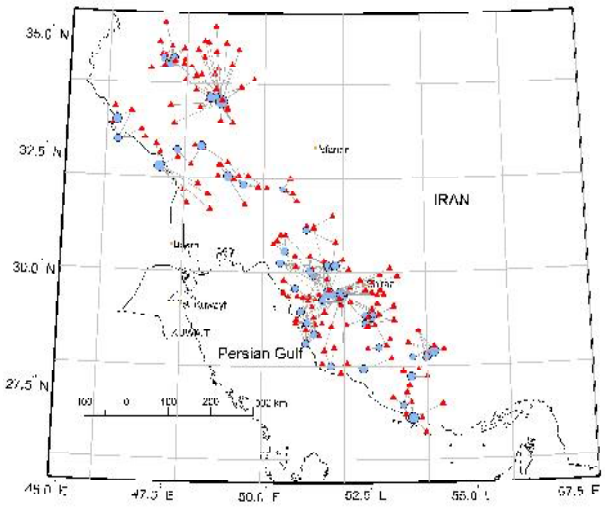

Figure 1. Earthquakes (circles) and stations (triangles) used in the study

We applied weighted least squares method to estimate the unknown coefficients of a number of models, and eventually the simple functional form of Equation 6 is chosen to represent the variation of CAV definitions with respect to distance and magnitude.

$$\log(CAV) = a + b\,M + c\log(R) \qquad (6)$$

Where, M is moment magnitude, R is hypocentral distance, and a, b and c are unknown coefficients. Results of the regression analysis are shown in Table 1. As could be seen, CAV_{Total} have smaller standard deviation (STD) among other versions of CAV and it could be deduced that it is more predictable than others.

Table 1. Coefficients of a GMPE for CAV_{Total}, CAV_{STD} and CAV_5 and their standard deviation (STD) as well as their weight

Version of CAV	a	b	c	STD of a	STD of b	STD of c	Weight
CAV_{Total}	0.632	0.105	-0.455	0.052	0.010	0.016	0.468-0.145 *log*(*R*)
CAV_{STD}	0.681	0.185	-0.667	0.210	0.036	0.064	0.653-0.191 *log*(*R*)
CAV_5	0.464	0.216	-0.616	0.149	0.029	0.047	0.472-0.046 *log*(*R*)

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