

Div.I **Site amplifications of Iran major seismic zones**

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1. Objective of this study

Iran has situated in a high seismic potential area and many big earthquakes have been experienced there. In order of seismic hazard analysis, the seismometer network with 1,065 seismometers has been established and more than 6000 acceleration records have been recorded so far. Authors gathered a database consisting of records of earthquakes with M_w greater than 5.0 and obtained the attenuation relation for PGA, PGV and acceleration response spectra with 5% damping with respected to two major seismic zones of Iran (Central Iran and Zagros). Current study considers the site amplifications of ground type in the rage of shear velocity for the attenuation relations of Central Iran and Zagros zones.

2. Iran seismic zones

Basically, attenuation relations are shown based on the seismic zones. For Iran, there are two types of classification of seismic zones by Berbrian (1977) (Fig.1) and others. Since there is not too many record for each zone, researchers usually combined zones to two major zones as Central Iran and Zagros (bolded zones). In this study we propose our attenuation for these major zones.

3. Attenuation relations used in analysis

For obtaining of attenuation relation for Iran major zones, two-step regression analyses based on the methodology mentioned by Fukushima and Tanaka (1990) were used as following:

$$\log A(T) = a(T) \cdot M_w - \log(X + d(T) \cdot 10^{e \cdot M_w}) - b(T) \cdot X + c(T) \tag{1}$$

where A is ground motion parameter, we use PGA, PGV and spectral acceleration in each period, M_w is moment magnitude, X is shortest distance to fault (or hypocenter), a , b , c , d and e are coefficients of regression analysis.

Earthquakes with M_w more than 5.0 were used for the regression. Acceleration recorded on the ground surface, having two orthogonal horizontal components was also selected. A database consisting of 246 triaxial accelerograms form 59 earthquakes for Central Iran zone and 150 triaxial accelerograms from 51 earthquakes for Zagros zone were gathered for our analysis. We provided the coefficients by this basic database with respect to the rock and soil ground conditions.

On the other hand, since about 500 stations from 1065 seismometers of Iran have classified by site geology investigation of Building and Housing Research Center of Iran, we could use average shear velocity for 400 of total gathered

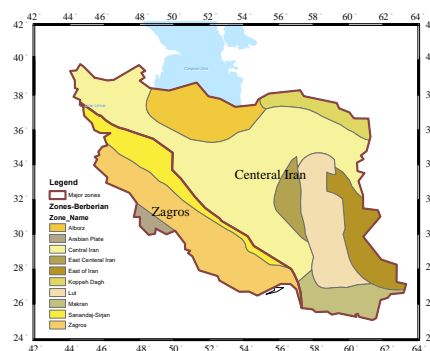


Fig.1 Iran seismic zones (Edited on Berberian, 1977)

Table 1. Shear velocity groups for major zones of Iran

Group	Range of V_s	Central Iran zone		Zagros zone	
		No.	Ave. (m/s)	No.	Ave. (m/s)
I	$750 < V_s$	76	1005	73	990
II	$375 < V_s < 750$	120	567	63	548
III	$175 < V_s < 375$	50	305	14	329
IV	$V_s < 175$	-	-	-	-
Subtotal		246		150	

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records used in analysis. Table 1 shows the shear velocity groups (corresponding to Iran seismic code, Standard 2800), number of stations and average of shear velocity for each group and zone, matched with stations used in the above basic attenuation study. As it is seen in Table 1, there is not any shear velocity record in group IV. Also, 14 records for Group III in Zagros zone are not enough to obtain reasonable coefficient of the regression analysis. Therefore we obtained c coefficients by the group (in three ranges for Central Iran zone and two ranges for Zagros zone, by using the predicted model of basic attenuation relation with rock ground condition. Table 2 and Fig. 2 show the coefficients by the regression analysis.

Fig. 3 shows amplification rate (rate of Group II or III coefficient to Group I coefficient) for Central Iran and Zagros zones. As it is seen in Fig. 3, the amplification rate in Zagros zone/ Group II shows lower amplification than that of Central Iran/ Group II.

The amplification rates are 1.17 for PGA and 1.18 for PGV by (GIII/GI) and 2.09 for PGA and 2.34 for PGV for (GIII/GI) in Central Iran zone and 1.01 for PGA and 1.18 for PGV by (GII/GI) and 1.16 for PGA and 1.23 for PGV by (GIII/GI) for Zagros zone.

4. Conclusion

In the present study, amplification for GI~GIII in two seismic zones has been obtained by regression analysis employing many records in Iran.

Amplification is a little smaller than Japanese bridge code in corresponding ground sites.

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References:

Berberian, M., A., Mohajer-Ashjai: Seismic risk map of Iran, a proposal, Geol. Surv. Iran, 41, pp121-148, 1977
 BHRC, Iranian code of practice for seismic resistant design of buildings, Standard 2800, 3rd edition, 2007

Table 2. Coefficients of regression analysis for Central Iran and Zagros

(a) Central Iran									(b) Zagros								
T	a	b	CI	CII	CIII	σ_I	σ_{II}	σ_{III}	T	a	b	CI	CII	CIII	σ_I	σ_{II}	σ_{III}
PGA	0.426	0.0031	1.003	1.072	1.324	0.357	0.372	0.349	PGA	0.465	0.0078	1.113	1.119	1.176	0.414	0.352	0.250
0.05	0.450	0.0047	1.030	1.069	1.217	0.280	0.310	0.297	0.05	0.376	0.0103	1.861	1.799	1.977	0.406	0.351	0.268
0.1	0.478	0.0038	0.968	1.056	1.220	0.317	0.318	0.321	0.1	0.473	0.0095	1.435	1.439	1.524	0.433	0.359	0.318
0.15	0.490	0.0033	0.901	1.008	1.197	0.304	0.320	0.322	0.15	0.540	0.0087	1.050	1.095	1.133	0.377	0.373	0.331
0.2	0.498	0.0031	0.829	0.941	1.150	0.295	0.299	0.314	0.2	0.582	0.0081	0.761	0.829	0.847	0.366	0.385	0.320
0.25	0.505	0.0029	0.749	0.860	1.085	0.293	0.282	0.338	0.25	0.611	0.0076	0.537	0.616	0.627	0.337	0.377	0.309
0.3	0.512	0.0029	0.662	0.770	1.006	0.291	0.275	0.341	0.3	0.632	0.0072	0.355	0.438	0.451	0.331	0.363	0.362
0.4	0.530	0.0029	0.475	0.575	0.825	0.333	0.276	0.340	0.4	0.659	0.0065	0.067	0.151	0.175	0.359	0.353	0.380
0.5	0.549	0.0030	0.280	0.371	0.628	0.340	0.291	0.330	0.5	0.676	0.0058	-0.158	-0.079	-0.039	0.359	0.356	0.339
0.6	0.570	0.0030	0.083	0.168	0.427	0.340	0.285	0.316	0.6	0.689	0.0053	-0.347	-0.275	-0.219	0.357	0.351	0.310
0.7	0.590	0.0031	-0.110	-0.031	0.228	0.310	0.295	0.294	0.7	0.699	0.0048	-0.511	-0.447	-0.376	0.345	0.366	0.337
0.8	0.611	0.0031	-0.298	-0.223	0.033	0.306	0.293	0.296	0.8	0.707	0.0043	-0.658	-0.602	-0.518	0.346	0.372	0.357
0.9	0.631	0.0031	-0.479	-0.407	-0.155	0.308	0.306	0.322	0.9	0.715	0.0039	-0.793	-0.744	-0.648	0.355	0.366	0.379
1	0.651	0.0032	-0.653	-0.583	-0.335	0.309	0.305	0.334	1	0.722	0.0035	-0.918	-0.876	-0.770	0.366	0.364	0.380
1.5	0.736	0.0031	-1.408	-1.342	-1.119	0.323	0.333	0.326	1.5	0.755	0.0020	-1.446	-1.426	-1.292	0.380	0.372	0.368
2	0.803	0.0028	-2.005	-1.935	-1.736	0.318	0.351	0.329	2	0.786	0.0009	-1.880	-1.869	-1.730	0.360	0.362	0.340
2.5	0.851	0.0024	-2.464	-2.389	-2.208	0.306	0.370	0.339	2.5	0.816	0.0002	-2.250	-2.239	-2.110	0.352	0.362	0.347
3	0.886	0.0020	-2.823	-2.742	-2.574	0.304	0.373	0.371	3	0.845	-0.0003	-2.578	-2.561	-2.450	0.345	0.350	0.336
4	0.920	0.0010	-3.295	-3.207	-3.051	0.314	0.366	0.337	4	0.900	-0.0009	-3.135	-3.094	-3.035	0.345	0.356	0.306
5	0.920	0.0000	-3.532	-3.443	-3.283	0.326	0.369	0.317	5	0.949	-0.0009	-3.597	-3.523	-3.526	0.345	0.363	0.293
PGV	0.561	0.0026	-1.012	-0.940	-0.642	0.411	0.413	0.447	PGV	0.613	0.0063	-1.084	-1.013	-0.993	0.413	0.397	0.288

Parameters d and e are considered equal to 0.005 and 0.5 in this study.

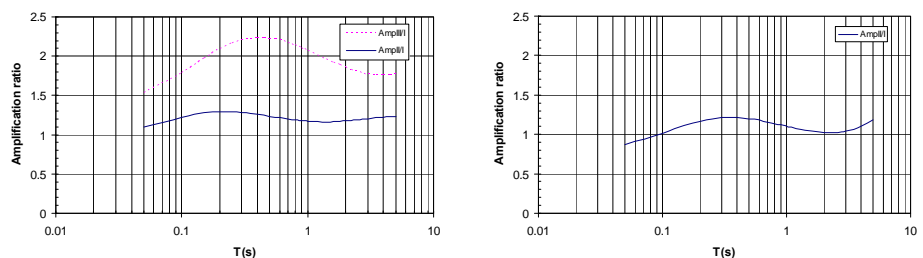
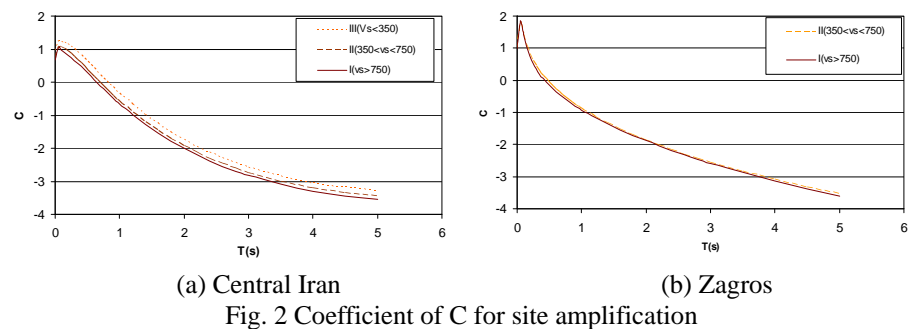


Fig. 3 Amplification ratios for Central Iran and Zagros zones