



Technical Report

**THE MOST IMPORTANT CHARACTERISTICS OF STRONG
GROUND MOTION DATA IN IRAN IN 2012**

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Received: 5 February 2014; **Accepted:** 15 April 2014

ABSTRACT

During January – December 2012 more than 1341 records were recovered from permanent Iran strong motion stations operated by the Road, Housing and Urban Development Research Center. Accelerograms were recovered from ISMN triggered by 634 earthquakes in the magnitude 2.0 to 6.4 ranges. Peak ground acceleration was recorded in Chaykandi1 station about 607 cm/s² on September 27th, 2012 earthquake.

Keywords: Accelerogram; accelerograph; earthquake; strong motion; peak ground acceleration.

1. INTRODUCTION

The Iranian plateau is one of the seismically active areas of the world and frequently suffers destructive earthquakes that cause heavy loss of human life and widespread damage. Safeguarding life and property from destructive effects of earthquakes is a major national as well as world-wide problem. Earthquake strong motion data provide the basis for design of engineered buildings, bridges, dams and other critical structures as well as the basis for research on fundamental problems related to earthquake processes, and internal structure of the earth. Strong motion instrumentation program in Iran is operated by ISMN.

Iran Strong Motion Network (ISMN) started its activities in 1973 at the former Planning and Budget Organization. In 1981, the ISMN was transferred to BHRC and a new phase of its activities began. Until 1992, the ISMN had 274 analog accelerographs. At the present time (March 2014) ISMN has 1140 digital accelerographs. More than 10150 three component accelerograms have been recorded by these instruments.

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2. STRONG MOTION DATA IN 2012

During January – December 2012, 634 earthquakes triggered 178 accelerographs, among them 109 earthquakes had magnitude greater than 4 (Figure 1 and 2). In addition, more than 1341 accelerograms were recovered from the permanent Iran Strong Motion Network, operated by the Road, Housing & Urban Development Research Center (Figure3). The most important earthquake in 2012 was the Ahar- Varzaqan doublet event on August 11, at 12:23:15 with M_n 6.4 and 6.2 (IGTU) in East Azarbaijan Province. Fifty eight accelerographs were triggered by the first event, but in second event 75 accelerographs triggered. The maximum peak ground acceleration of the first event was 478 cm/s^2 on horizontal component recorded in Satarkhan dam 3 and 427 cm/s^2 in Varzaqan station. In the second event PGA was 532 cm/s^2 on horizontal component recorded in Varzaqan.

The highest acceleration in 2012 recorded at Chaykandi1 station in the one of the Ahar varzaqan aftershocks event in September 27th, 2012 (607 cm/s^2).

In appendix table we classify the information collected for each entry in the database under three headings: (1) Earthquake information (date, epicentral coordinates, magnitude, and depth), (2) Station information (coordinates, location, ID, altitude,) and (3) record information (trigger times, peak ground motion amplitudes of each waveform). The earthquake information was obtained from both national and international seismic agencies. We processed all records with $M \geq 4$, and only for these records PGV, PGD and spectral quantities were computed because ground motion records of events with smaller magnitudes are unlikely to be significant for engineering use. The most important earthquakes in 2012 are listed in below.

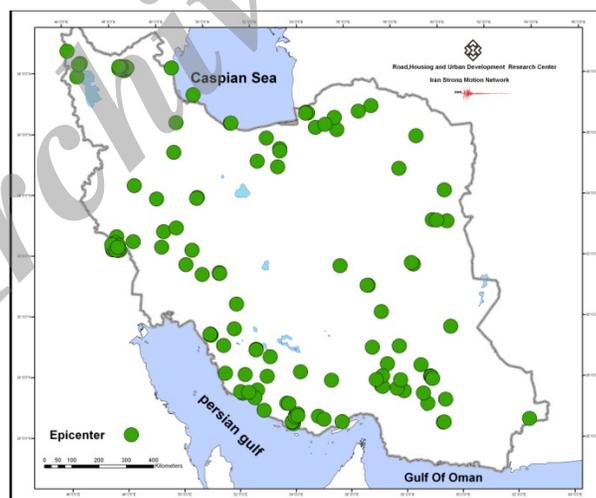


Figure 1. The epicentres of the earthquakes occurred in Iran and neighbouring countries that recorded by ISMN in 2012

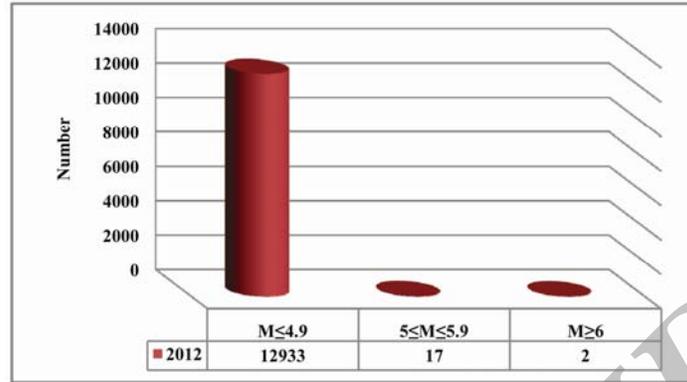


Figure 2. The number of earthquakes in 2012

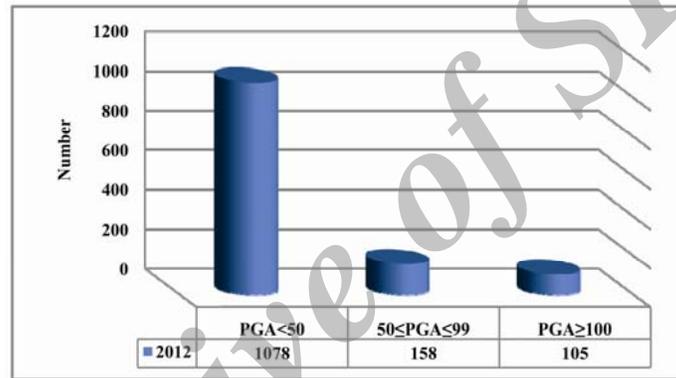


Figure 3. The number of accelerograms in 2012

The most important earthquakes in 2012 are listed in below.

2.1 Babol Earthquake of January 11th, 2012 (Mazandaran Province)

On January 11th, 2012 at 17:08:00 (UTC), a moderate earthquake with Mw4.9 (BHRC), Mn5.0 (IGTU), Ml5.2 (IIEES) and mb5.1 (NEIC), occurred near the Babol city (Mazandaran Province) in North of Iran. This event was recorded by 14 sets of digital accelerographs of Iran Strong Motion Network (ISMN) (Figure 4). The uncorrected peak acceleration of about 33 cm/s² was recorded in Babol station (Figure5). The epicenter of this event was located in 36.38N, 52.74E (BHRC), 36.33N, 52.78E (IGTU), 36.37N, 52.83E (IIEES) and 36.23N, 52.77E (NEIC).

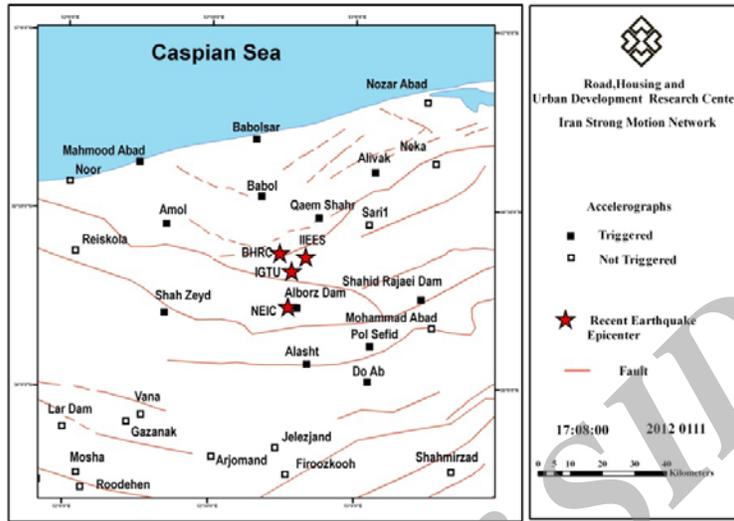


Figure 4. The location map of January 11th, 2012 Babol earthquake and triggered stations

Date	Record No.	Strong Motion Parameters	Components		
			L	V	T
2012/01/11	5362	Corrected Acceleration (cm/s ²)	32	14	11
		Velocity (cm/s)	2.6	0.6	0.6
		Displacement (cm)	0.35	0.05	0.06
17:08:00		Duration (sec)	18	20	24

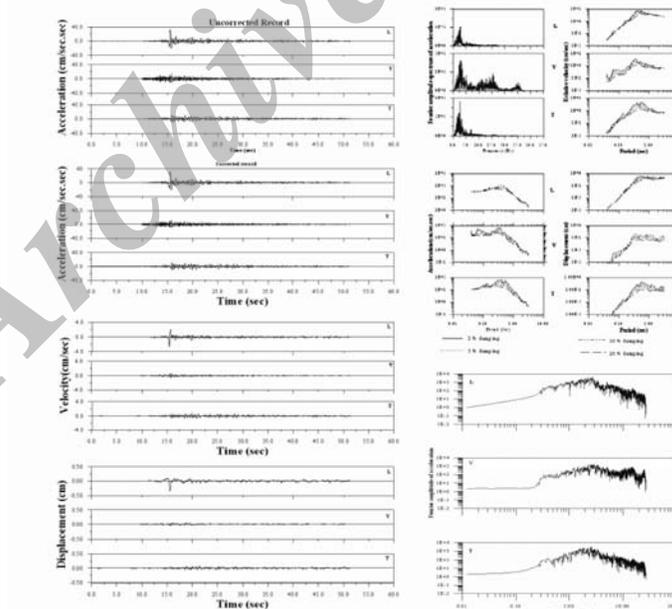


Figure 5. Uncorrected & corrected time-histories, response and Fourier spectrums of Babol accelerogram

2.2 Neyshaboor Earthquake of January 19th, 2012 (Khorasan Razavi province)

on January 19th, 2012 at 12:35:51 (UTC), a relatively strong earthquake with Mw5.2 (BHRC), Mn5.5 (IGTU), M15.4 (IIEES) and Mw5.1 (NEIC) struck some part of Khorasan Razavi province near Neyshaboor city in North-East of Iran. This event was recorded by 15 sets of digital accelerographs (Figure 6) of Iran Strong Ground Motion Network (ISMN). The uncorrected peak acceleration (271 cm/s^2) was recorded in Neyshaboor station (Figure 7). The epicenter of this event was located in 36.34N, 58.92E (BHRC), 36.29N, 58.84E (IGTU), 36.30N, 58.86E (IIEES) and 36.28N, 58.89E (NEIC).

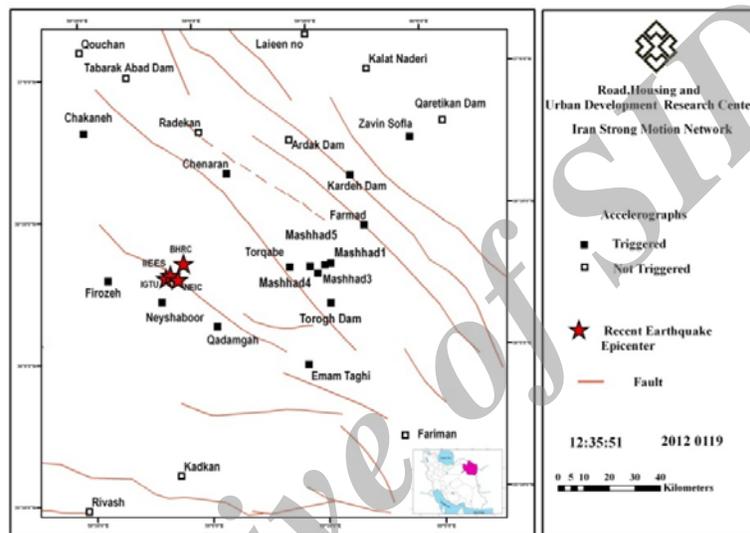


Figure 6. The location map of January 19th, 2012 Neyshaboor earthquake and triggered stations

2.3 Murmuri Earthquake of May 3th, 2012 (Ilam Province)

On the 3th of May, 2012 at 10:09:37 (UTC), a relatively strong earthquake with the magnitude of Mw5.5 (BHRC), Mn5.5 (IGUT), M15.4 (IIEES) and Mw5.5 (NEIC), struck some parts of Ilam province near Murmuri town in west of Iran. This event was recorded by 8 sets of digital accelerographs of Iran Strong Motion Network (ISMN) (Figure 8). The maximum uncorrected peak acceleration of about 155 cm/s^2 was recorded in Murmuri station (Figure 9). The epicenter of this event has been located at 32.88N, 47.72E (BHRC), 32.74N, 47.61E (IGUT), 32.81N, 47.61E (IIEES) and 32.81 N, 47.71E (NEIC).

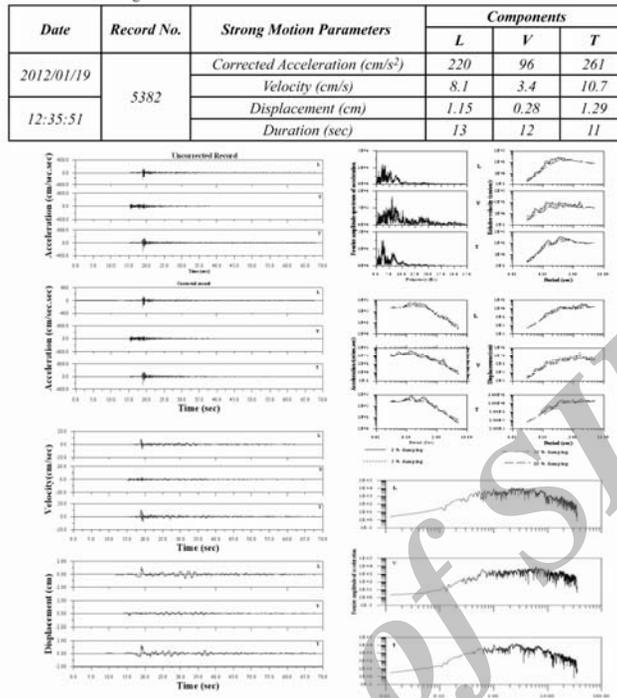


Figure 7. Uncorrected and corrected time-histories, response and Fourier spectra of Neyshaboor accelerogram

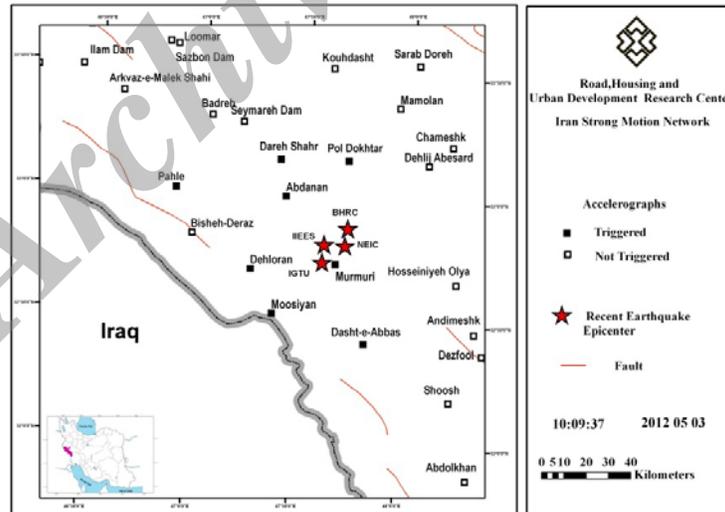


Figure 8. The location map of May 3th, 2012 Murmuri earthquake and triggered stations

Date	Record No.	Strong Motion Parameters	Components		
			L	V	T
2012/05/03	5449	Corrected Acceleration (cm/s ²)	155	122	139
		Velocity (cm/s)	3.5	2.0	4.0
		Displacement (cm)	0.30	0.32	0.44
10:09:37		Duration (sec)	5	8	6

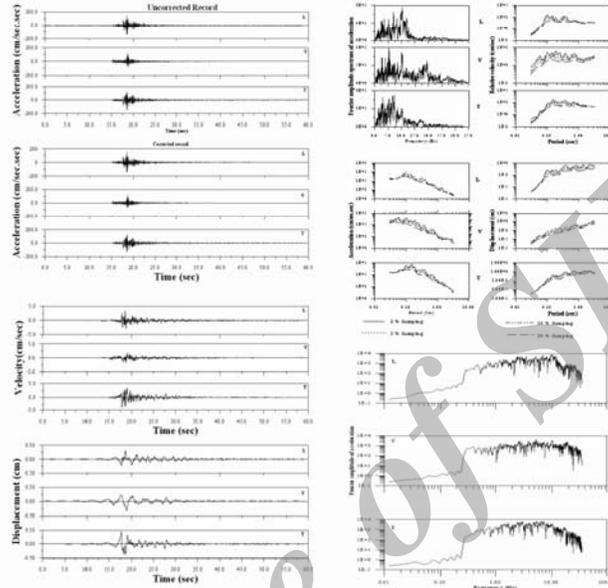


Figure 9. Uncorrected and corrected time-histories, response and Fourier spectrums of Murmuri accelerogram

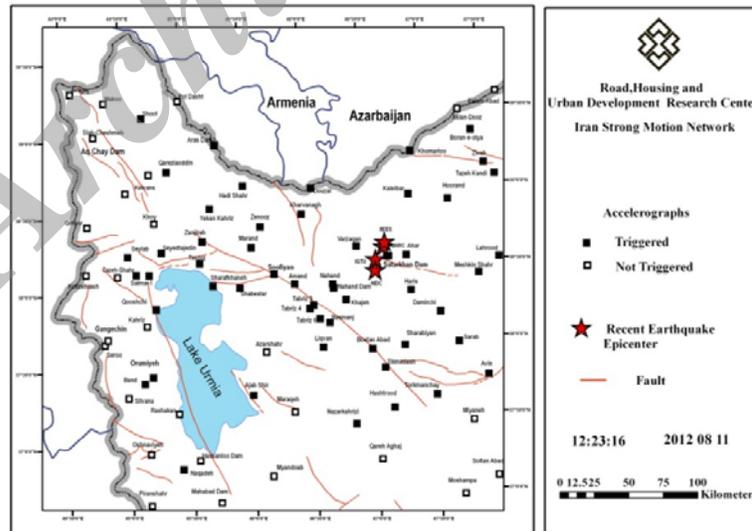


Figure 10. The location map of August 11th, 2012 Ahar-Varzaqan earthquake and triggered stations

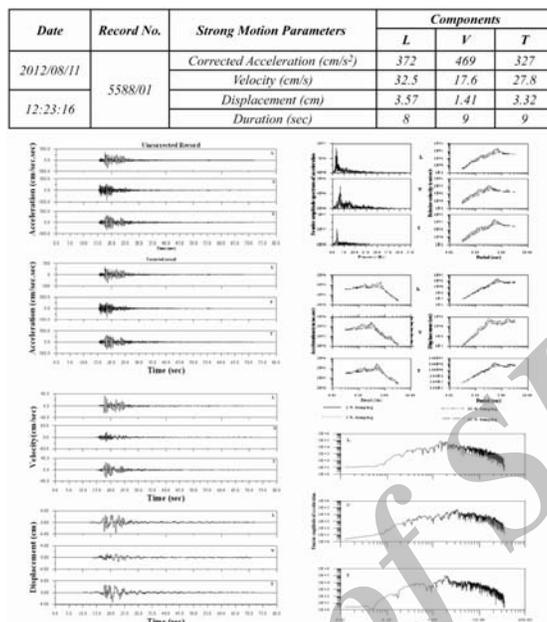


Figure 11. Uncorrected & corrected time-histories, Response and Fourier spectrums of the Satarkhan Dam 3 earthquake

2.5 The Second Ahar-Varzaqan Earthquake of August 11th, 2012

The second destructive earthquake happened 11 minute after the first one, while the small earthquake still was going on in the region. The second earthquake with calculated magnitude, according to accelerographs had 6.3 magnitude. This earthquake was recorded by 73 strong motion stations (figure 12). The maximum acceleration registered at this earthquake was around 530 cm/s² in Varzaqan station (figure13). A closer look to the registered accelerographs at stations close to second earthquake's epicenter shows that a smaller earthquake had happened 5 minutes before the second one, and could only be registered by stations of strong motion network.

We could separate and registered this earthquake from the second one; this earthquake was registered with ID No 5579-3, in Varzaqan station.

The acceleration of this small earthquake was larger than 4 cm/s² and the maximum acceleration for second earthquake was bigger than 500 cm/s² in Varzaqan station. The maximum significant duration of this station was between 5-8.5 second and predominant period was 0.16 second on L component and the 0.06, 0.26 on V and T components respectively.

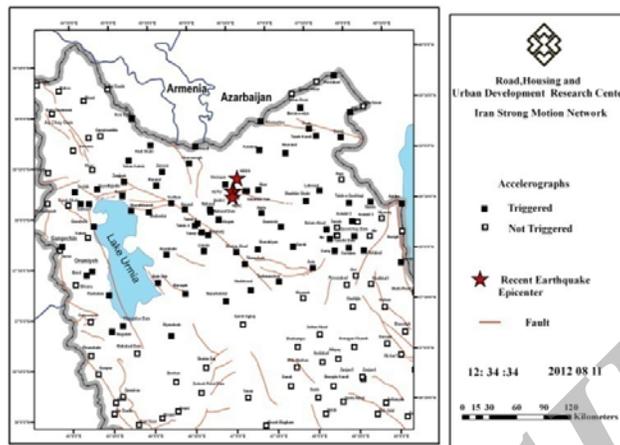


Figure 12. The location map of August 11th, 2012 Ahar-Varzaqan earthquake and triggered stations

Date	Record No.	Strong Motion Parameters	Components		
			L	V	T
2012/08/11	5579/04	Corrected Acceleration (cm/s ²)	500	206	520
		Velocity (cm/s)	30.3	9.2	35.5
		Displacement (cm)	5.93	1.44	5.08
12:34:34		Duration (sec)	7	9	6

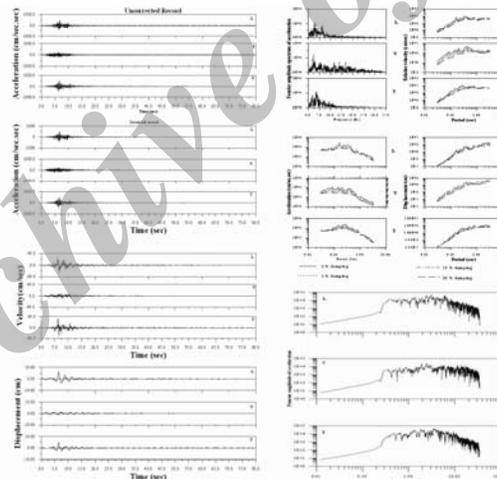


Figure 13. Uncorrected & corrected time-histories, response and Fourier spectrums of Varzaqan accelerogram

2.6 Ahar-Varzaqan Earthquake Aftershock of August 11th, 2012

After successive earthquakes in the Ahar-Varzaqan region, at 22:24:02 (UTC), an aftershock with Mw5.1 (BHRC), Mn4.8 (IGTU), Ml4.9 (IIEES) and mb5.1 (NEIC) occurred near Ahar city. This event was recorded by 14 sets of digital accelerographs (Figure 14) of Iran Strong Ground Motion Network (Hoorand, Ahar, Nahand Dams 1, 2 and 3, Douzal, Khajeh, Kaleibar, Damirchi, Nahand, Meshkin Shahr, Kharvanagh, Ziveh and Tazeh Kandi). The maximum uncorrected peak acceleration of about 69 cm/s² was recorded in Hoorand station

(Figure 15). The epicenter of this event has been located at 38.47N, 46.75E (BHRC), 38.48N, 46.76E (IGTU), 38.46N, 46.72E (IIEES) and 38.46N, 46.72E (NEIC).

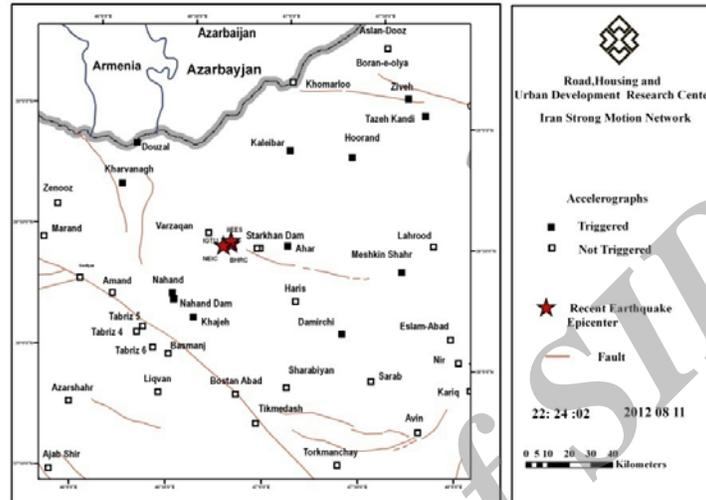


Figure 14. The location map of August 11th, 2012 Ahar-Varzaqan earthquake and triggered stations

Date	Record No.	Strong Motion Parameters	Components		
			L	V	T
2012/08/11	5544/07	Corrected Acceleration (cm/s ²)	68	18	31
		Velocity (cm/s)	1.9	0.4	0.9
		Displacement (cm)	0.07	0.03	0.05
22:24:02		Duration (sec)	4	14	13

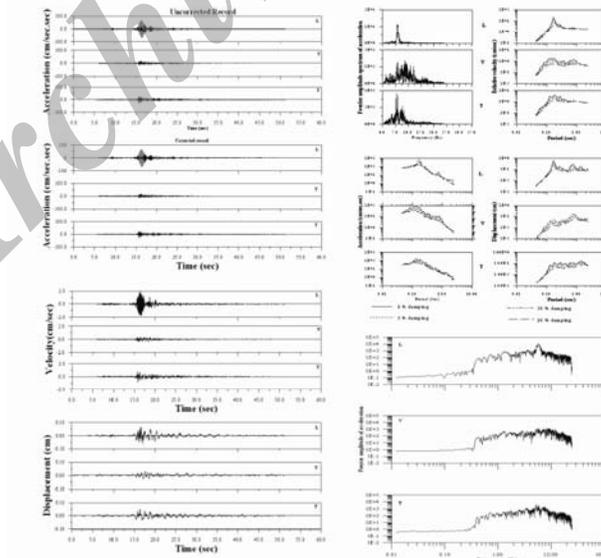


Figure 15. Uncorrected and corrected time-histories, response and Fourier spectrums of Hoorand accelerogram

2.7 Ahar-Varzaqan Earthquake Aftershock of August 14th, 2012

In last months of 2012, the Ahar-Vazaqan region was remaining vulnerable to earthquakes. On August 14th, at 14:02:25 (UTC), a strong aftershock with Mw5.5 (BHRC), Mn5.3 (IGTU), M15.2 (IIEES) and mb5.1 (NEIC) jolted Ahar-Varzaqan area. This event was recorded by 22 sets of digital accelerographs (Figure 16) of ISMN (Varzaqan , Chaykandi, Satarkhan Dams 1,2 and 3, Mehtar1, Sheikh-Khomloo, Khajeh, Nahand Dams 1, 2 and 3, Ahar, Kharcanagh, Hoorand, Kaleibar, Heris, Meshkin Shahr, Douzal, Nahand, Liqvan, Basmanj and Hadi Shahr). The maximum uncorrected peak acceleration of about 381 cm/s² was recorded in Varzaqan station (Figure17). The epicenter of this event was at 38.38N, 46.76E (BHRC), 38.45N, 46.79E (IGTU), 38.46N, 46.79E (IIEES) and 38.35N, 46.75E (NEIC).

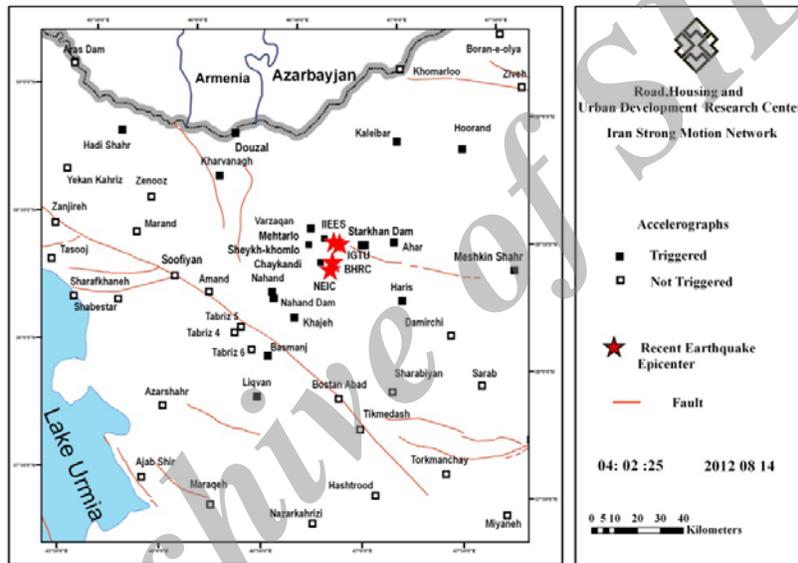


Figure 16. The location map of August 14th, 2012 Ahar-Varzaqan earthquake and triggered stations

2.8 Ahar-Varzaqan Earthquake Aftershock of August 15th, 2012

On August 15th, 2012 at 17:49:04 (UTC), another strong aftershock with Mw5.3 (BHRC), Mn5.0 (IGTU), M15.1 (IIEES) and mb5.3 (NEIC), occurred in the Ahar-Varzaqan macroseismic area. This event was recorded by 15 sets of digital accelerographs of Iran Strong Motion Network (ISMN) in (Chaykandi1, Nahand Dams 1, 2 and 3, Nahand, Varzaqan, Satarkhan Dam 1, 2 and 3, Ahar, Khajeh, Douzal, Meshkin Shahr, Heris and Hoorand (Figure 18). The uncorrected peak acceleration of about 406 cm/s² was recorded in Chaykandi1 station(Figure19).The epicenter of this event was located in 38.35N, 46.61E (BHRC), 38.41N, 46.67E (IGTU), 38.45N, 46.66E (IIEES) and 38.40N, 46.69E (NEIC).

Date	Record No.	Strong Motion Parameters	Components		
			L	V	T
2012/08/14	5589/07	Corrected Acceleration (cm/s ²)	373	90	144
		Velocity (cm/s)	13.7	2.7	7.5
14:02:25		Displacement (cm)	1.15	0.18	0.92
		Duration (sec)	4	8	4

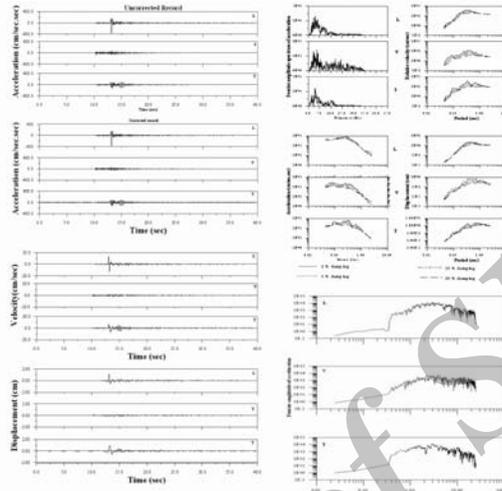


Figure 17. Uncorrected & corrected time-histories, Response and Fourier spectrums of Varzaqan accelerogram

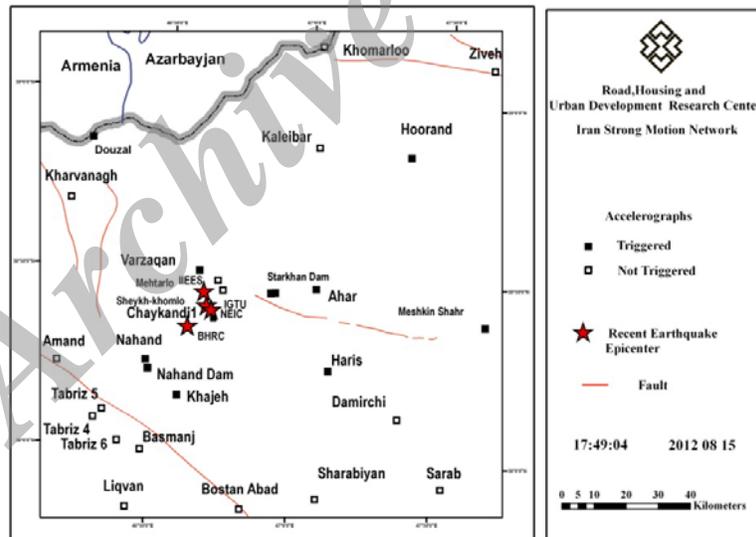


Figure 18. The location map of August 15th, 2012 Ahar-Varzaqan earthquake and triggered stations

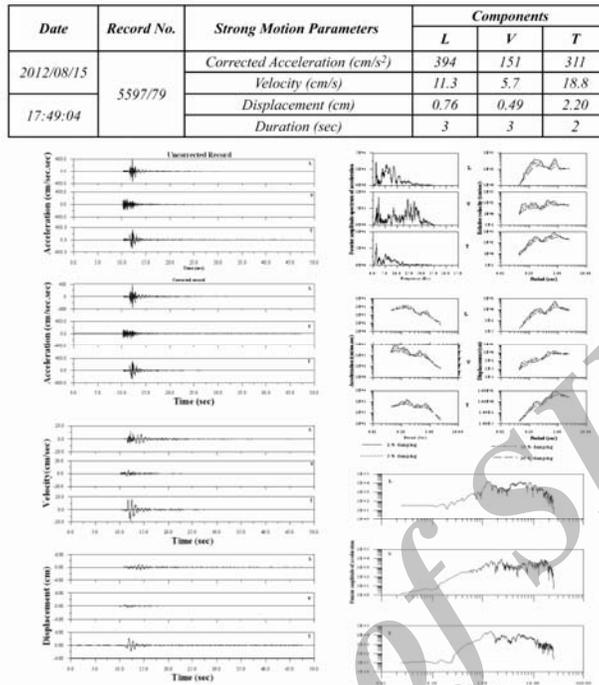


Figure 19. Uncorrected & corrected time-histories, response and Fourier spectra of Chaykandi 1 accelerogram

2.9 Ahar-Varzaqan Earthquake Aftershock of September 27th, 2012

On September 27th, 2012 at 00:56:00 (UTC), an aftershock with Mw4.8 (BHRC), Mn4.5 (IGTU), M14.3 (IIEES) and mb4.5 (NEIC) jolted villages near Varzaqan town. This event was recorded by 8 sets of digital accelerographs (Figure 20) of Iran Strong Ground Motion Network (Chaykandi 1, Mehtarlo 1, Varzaqan and Satarkhan Dam1, Nahand Dam 2 and 3, Khajeh and Ahar). The maximum uncorrected peak acceleration was very high and reached to 607 cm/s² in Chaykandi 1 station (Figure21). The epicenter of this event has been located at 38.39N, 46.58E (BHRC), 38.42N, 46.63E (IGTU), 38.47N, 46.64E (IIEES), 38.47N, 46.64E (NEIC).

2.10 Ahar-Varzaqan Earthquake Aftershock of November 7th, 2012

On November 7th, at 06:26:31 (UTC), another strong aftershock with Mw5.3 (BHRC), Mn5.1 (IGTU), M15.0 (IIEES) and mb5.5 (NEIC) struck Varzaqan town vicinity, near Sheykh-Khomloo village. This event was recorded by 17 sets of digital accelerographs (Figure 22) of Iran Strong Ground Motion Network (Sheykh-Khomloo, Varzaqan, Chaykandi 1, Mehtarlo 1, Satarkhan Dam 1 and 2, Nahand Dams1, 2 and 3, Nahand, Khajeh, Ahar, Kaleibar, Hoorand, Haris, Kharvanagh and Khomarloo). The maximum uncorrected peak acceleration was very high and reached to 460 cm/s² in Sheykh-Khomloo station (Figure 23). The epicenter of this event has been located at 38.45N, 46.52E (BHRC), 38.43N, 46.60E (IGTU), 38.52N, 46.60E (IIEES) and 38.47N, 46.61E (NEIC).

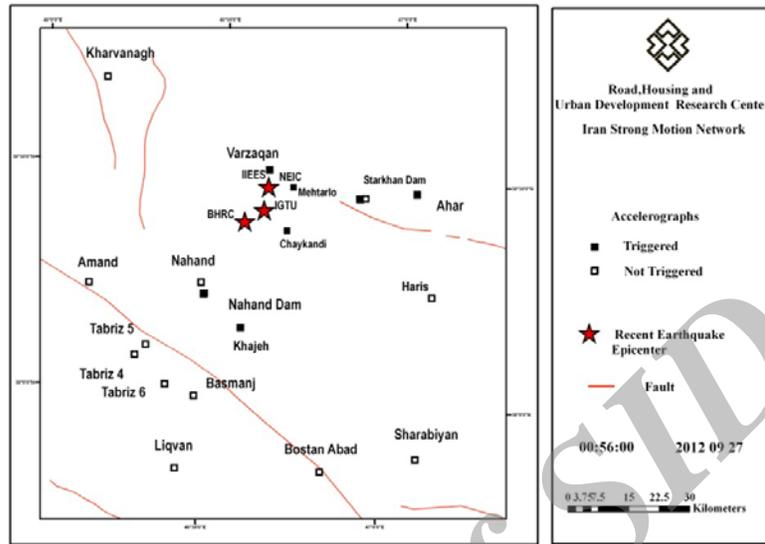


Figure 20. The location map of September 27th, 2012 Ahhar-Varzaqan earthquake and triggered stations

Date	Record No.	Strong Motion Parameters	Components		
			L	V	T
2012/09/27 00:56:00	5631/53	Corrected Acceleration (cm/s ²)	566	252	419
		Velocity (cm/s)	26.2	3.6	15.6
		Displacement(cm)	2.06	0.20	1.16
		Duration (sec)	1	3	1

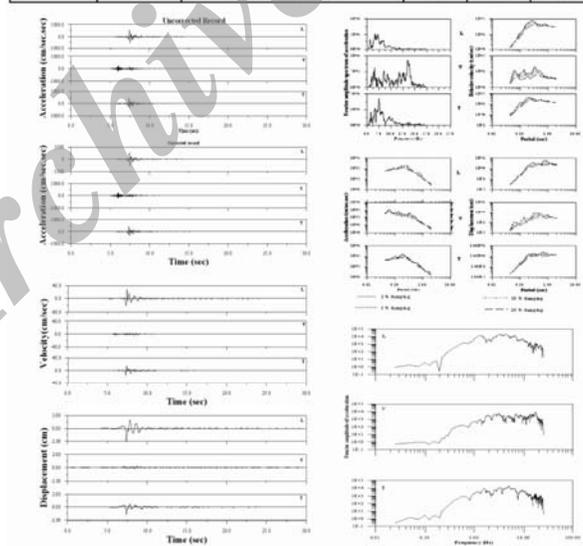


Figure 21. Uncorrected & corrected time-histories, response and Fourier spectrums of Chaykandi1 accelerogram

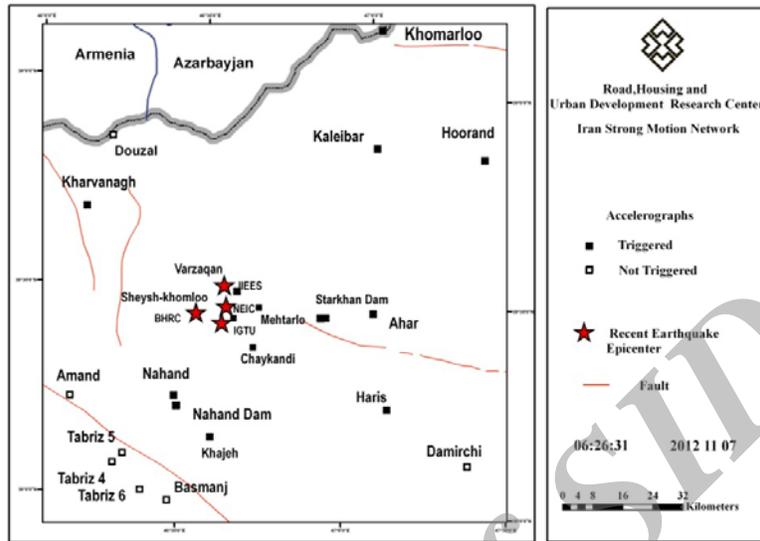


Figure 22. The location map of November 7th, 2012 Ahar-Varzaqan earthquake and triggered stations

Date	Record No.	Strong Motion Parameters	Components		
			L	V	T
2012/11/07	5715/13	Corrected Acceleration (cm/s ²)	376	397	417
		Velocity (cm/s)	38.9	12.4	14.2
		Displacement (cm)	4.53	1.02	1.44
06:26:31		Duration (sec)	3	4	4

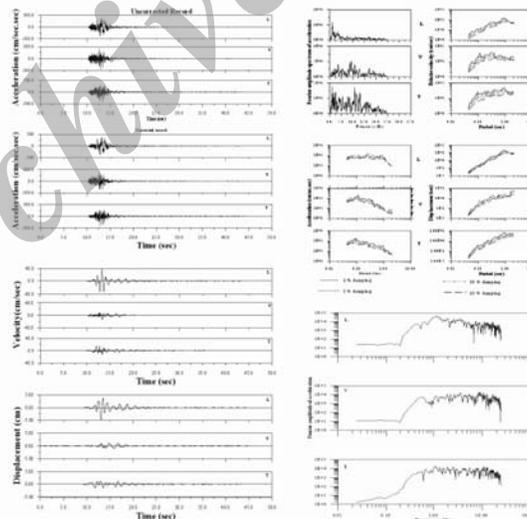


Figure 23. Uncorrected & corrected time-histories, response and Fourier spectrums of Sheykh-Khomloo accelerogram

2.11 Afin Earthquake of December 5th, 2012

On December 5th, at 17:08:11 (UTC), a moderate earthquake with Mw5.4 (BHRC), Mn5.5

(IGTU), M15.4 (IIEES) and mb5.6 (NEIC) occurred near Afin village in South Khorasan Province. This event was recorded by 8 sets of digital accelerographs (Figure 24) of Iran Strong Ground Motion Network (Afin, Sedeh, Haji Abad, Abiz, Asadiyeh, Shah Rakht, Qaen 2 and Farrokhi). The maximum uncorrected peak acceleration of about 143 cm/s^2 was recorded in Afin station (Figure25). The epicenter of this event has been located at 33.44N, 59.56E (BHRC), 33.50N, 59.54E (IGTU), 33.47N, 59.56E (IIEES) and 33.49N, 59.55E (NEIC).

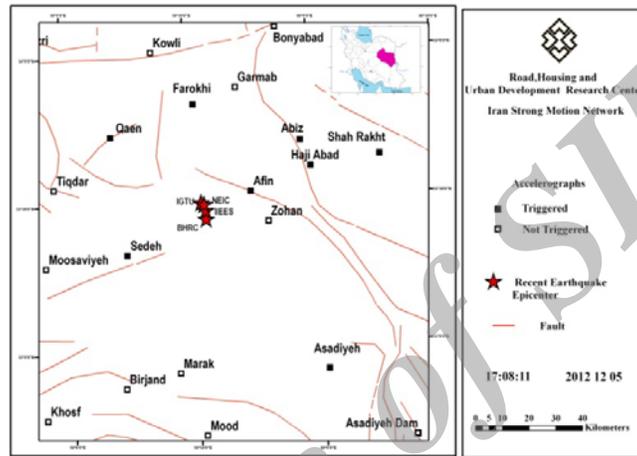


Figure 24. The location map of December 5th, 2012 Afin earthquake and triggered stations

Date	Record No.	Strong Motion Parameters	Components		
			L	V	T
2012/12/05	5684	Corrected Acceleration (cm/s^2)	140	74	96
		Velocity (cm/s)	10.1	3.9	5.2
		Displacement (cm)	1.87	0.50	0.73
17:08:11		Duration (sec)	5	6	6

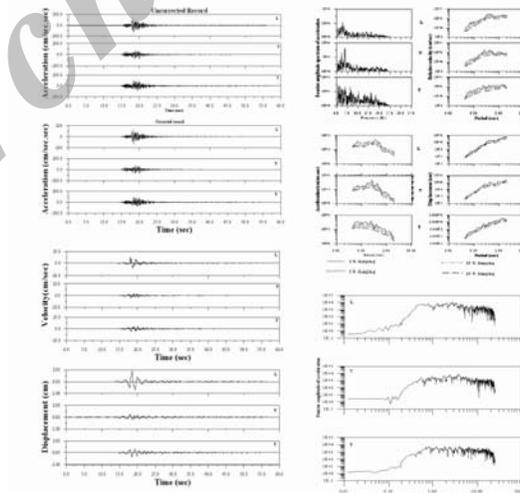


Figure 25. Uncorrected & corrected time-histories, response and Fourier spectrums of Afin accelerogram

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