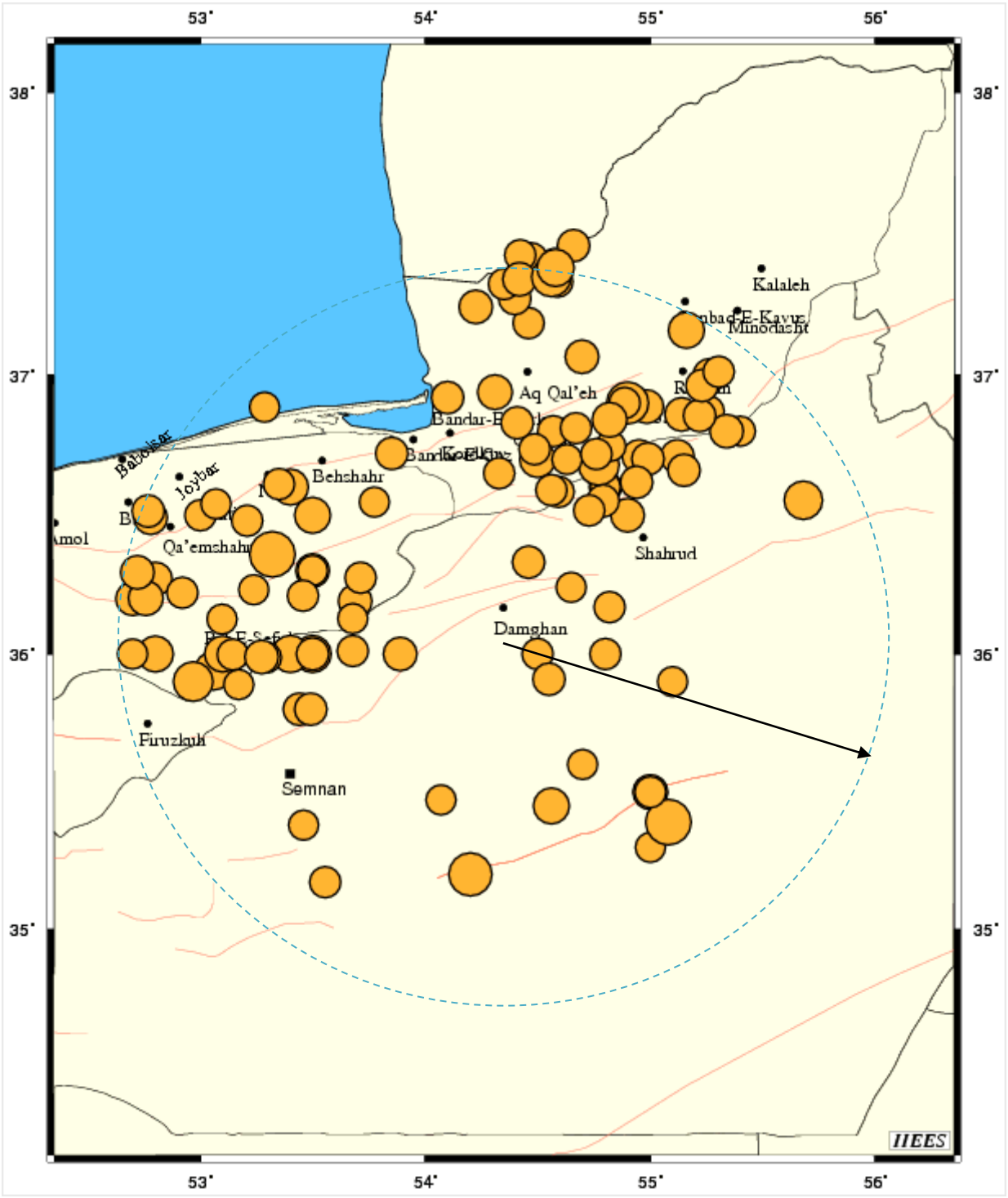
بسمه تعالی

تحلیل ریسک

بررسی زلزله دامغان

استاد : پروفسور غفوری آشتیانی

ابوذر میرزاخانی


53°
54°
55°
56°
38°
37°
36°
35°
Kalaleh
Aq Qal'eh
Behshahr
Joybar
Qa'emshahr
Shahrud
Damghan
Firuzkuh
Semnan
IIEES

Center City: Damghan (36.166, 54.349) Radius: 150 Magnitude (Min):4.5

Circular Search Earthquake Catalogue Search with following parameters:

This search was done on 2008/02/11 16:47 Order by: Date, Ascending Found: 112

	Date(m/d/y)	UTC.Time	Local.Time	Lat.	Lon.	D.	Mag.	Ref.	Region
1	1/2/1903	0:07:15	3:37:15	36.5	54.9	25	Mw:5.5*	MEA	Shahrud, Semnan P.
2	10/24/1917	11:00:00	14:30:00	36.94	54.31		Mw:5.6	AMB	West of Aq Qaleh, Golestan P.
3	7/3/1924	8:18:50	11:48:50	35.5	55		mb:5	ISS	South of Shahrud, Semnan P.
4	7/22/1927	3:54:54	7:24:54	35.2	54.2	33	mb:6.5	BER,M	South-East of Semnan, Semnan P.
5	4/14/1928	13:16:33	16:46:33	35.5	55		M:5.2	ISS	South of Shahrud, Semnan P.
6	5/20/1932	19:16:11	22:46:11	36.5	53.5		Mw:5.7	MEA	South of Behshahr, Mazandaran P.
7	3/5/1935	10:26:00	13:56:00	35.94	53.06		Mw:6	AMB	South of Pol-E-Sefid, Mazandaran P.
8	4/11/1935	23:14:00	2:44:00	36.36	53.32		mb:6.8	AMB	South of Neka, Mazandaran P.
9*	4/11/1935	23:59:19	3:29:19	36.48	53.21	33	mb:4.7	NAB	East of Sari, Mazandaran Province
10	4/12/1935	0:11:14	3:41:14	36	53.1	89	Mw:5.7	MEA	South of Pol-E-Sefid, Mazandaran P.
11	4/12/1935	0:33:39	4:03:39	36	52.8	17	Mw:5.7	MEA	North of Firuzkuh, Tehran Province
12	4/12/1935	1:06:35	4:36:35	36	53.5	53	Mw:5.8	MEA	South-East of Pol-E-Sefid, Mazand...
13	4/12/1935	12:44:30	16:14:30	36	53.4	43	Mw:5.8	MEA	South-East of Pol-E-Sefid, Mazand..
14	4/12/1935	20:24:00	23:54:00	36.3	53.5		mb:4.5	ISS	South of Behshahr, Mazandaran P.
15	4/12/1935	22:31:48	2:01:48	36.3	53.5	12	Mw:5.5	MEA	South of Behshahr, Mazandaran P.
16	4/13/1935	2:29:02	5:59:02	36	53.5	40	Ms:5.4	MEA	South-East of Pol-E-Sefid, Mazand..
17	4/17/1935	13:36:35	17:06:35	36.3	53.5		mb:4.5	ISS	South of Behshahr, Mazandaran P.
18	4/6/1939	4:08:08	7:38:08	35.45	54.56		Mw:5.7	NOW	South-East of Damghan, Semnan P.
19	4/18/1942	6:10:00	9:40:00	35.3	55	12	M:4.5	CCP	South of Shahrud, Semnan Province
20	4/5/1944	18:06:02	21:36:02	36.7	54.5	13	mb:5.4	BER,M	South of Gorgan, Golestan Province
21	4/5/1944	18:29:30	21:59:30	36	54.8	12	M:4.7	CCP	South-East of Damghan, Semnan P.
22	11/5/1949	15:05:44	18:35:44	37.16	55.16	33	Mw:5.7	NAB	Azadshahr, Golestan Province
23	2/14/1950	0:06:07	3:36:07	36.87	55.26	94	Mw:5.2	NOW	South-East of Ramian, Golestan P.
24	11/13/1951	14:01:56	17:31:56	35.89	53.17	69	M:4.5	NOW	South-East of Pol-E-Sefid, Mazand..
25	5/20/1952	0:00:00	3:30:00	36.6	53.4	12	Mw:5.7	ULM	Neka, Mazandaran Province
26	10/9/1952	19:12:19	22:42:19	36.65	54.33		Mw:5.2	NOW	South-West of Gorgan, Golestan P.
27	2/12/1953	8:15:00	11:45:00	35.39	55.08	10	mb:6.9	A28	South-East of Shahrud, Semnan P.
28	2/13/1953	4:36:28	8:06:28	35.6	54.7		M:4.5	CP	South-East of Damghan, Semnan P.
29	4/18/1953	6:22:34	9:52:34	36.83	54.41	12	mb:4.8	BER,M	Gorgan, Golestan Province
30	7/11/1953	15:25:08	18:55:08	35.9	55.1		M:4.5	CP	South-East of Shahrud, Semnan P.
31	7/24/1953	5:30:56	9:00:56	36.8	55.4		M:4.5	CP	South-East of Ramian, Golestan P.
32	7/24/1953	16:29:30	19:59:30	35.5	55		M:4.7	CP	South of Shahrud, Semnan Province
33	8/24/1953	16:29:31	19:59:31	36	54.5		mb:4.7	STR	South-East of Damghan, Semnan P.
34	7/2/1957	3:45:00	7:15:00	36.2	52.7		M:5	PT	South of Babol, Mazandaran
35	7/9/1957	9:09:00	12:39:00	36	52.7		M:4.5	PT	North of Firuzkuh, Tehran Province

36	1/16/1958	2:25:00	5:55:00	36.5	53		M:4.6	PT	Sari, Mazandaran Province
37	6/17/1958	16:55:00	20:25:00	36.21	52.76		mb:4.5	NOW	South-West of Qaemshahr, Mazand..
38	6/25/1958	1:14:02	4:44:02	36.27	52.8	4	M:5	NOW	South of Qaemshahr, Mazandaran .
39	10/6/1958	9:29:22	12:59:22	37.41	54.47	3	Mw:5.5	NOW	North of Aq Qaleh, Golestan
40	3/8/1959	14:49:00	18:19:00	36.49	52.78	111	mb:5	NOW	Qaemshahr, Mazandaran Province
41	7/8/1962	9:02:00	12:32:00	36.6	54.8		M:4.9	CCP	North-West of Shahrud, Semnan P..
42	7/28/1962	9:02:00	12:32:00	36.6	54.8	11	Mw:5.1	MEA	North-West of Shahrud, Semnan P.
43	12/8/1962	9:02:54	12:32:54	36.55	54.79	15	Mw:5.3	BE	North-West of Shahrud, Semnan P.
44	12/1/1964	8:21:53	11:51:53	36.8	54.57	33	mb:4.6	ISC	East of Gorgan, Golestan Province
45	12/3/1964	22:32:38	2:02:38	36.8	55.34	33	mb:5	ISC	South-East of Ramian, Golestan P.
46	5/7/1965	1:03:05	4:33:05	36.17	54.82	62	mb:4.6	ISC	South-West of Shahrud, Semnan P.
47	10/3/1966	17:05:08	20:35:08	35.8	53.44	14	mb:4.9	ISC	North of Semnan, Semnan Province
48	8/6/1967	20:40:13	0:10:13	36.9	54.94	33	mb:4.5	ISC	Ali Abad, Golestan Province
49	9/2/1967	8:02:09	11:32:09	36.71	54.95	36	mb:5.1	ISC	South of Ali Abad, Golestan
50	11/10/1967	2:50:52	6:20:52	36	53.89	5	mb:5	ISC	South-West of Damghan, Semnan P.
51	12/10/1967	10:52:50	14:22:50	36.19	53.69	19	mb:5	ISC	West of Damghan, Semnan Province
52	5/19/1968	16:49:50	20:19:50	36.61	53.35	22	mb:4.6	ISC	Neka, Mazandaran Province
53	7/29/1968	16:03:43	19:33:43	36.72	53.85	14	mb:4.8	ISC	Bandar-e gaz, Golestan Province
54	12/12/1968	18:54:47	22:24:47	35.8	53.49	27	mb:4.9	ISC	North of Semnan, Semnan Province
55	1/26/1969	2:25:53	5:55:53	36.73	54.48	10	mb:4.7	BE	Gorgan, Golestan Province
56	9/25/1969	15:25:29	18:55:29	36.71	55.12	32	mb:5.1	ISC	South of Ramian, Golestan Province
57	1/27/1970	14:05:52	17:35:52	36.86	55.14	31	mb:5.1	ISC	South of Ramian, Golestan Province
58	4/3/1970	20:53:54	0:23:54	37.06	54.69	26	mb:5	BE	East of Aq Qaleh, Golestan Province
59	2/14/1971	16:27:34	19:57:34	36.55	55.68	15	Mw:5.7	BE	North-East of Shahrud, Semnan P.
60	3/16/1971	5:28:10	8:58:10	36.88	54.98	33	M:5	ISC	East of Ali Abad, Golestan Province
61	8/9/1971	2:54:38	6:24:38	36.2	52.75	30	mb:5.2	BE	West of Pol-E-Sefid, Mazandaran P.
62	10/15/1971	14:19:32	17:49:32	37.33	54.58	41	mb:4.6	ISC	North-East of Aq Qaleh, Golestan P.
63	2/23/1972	23:13:47	2:43:47	36.21	53.45	73	mb:4.6	ISC	East of Pol-E-Sefid, Mazandaran P.
64	8/8/1972	0:44:55	4:14:55	36.51	52.76	42	mb:4.8	ISC	Babol, Mazandaran Province
65	2/15/1973	15:13:09	18:43:09	36.88	53.28		M:4.5	ISC	Caspian Sea, North of Neka
66	11/5/1974	20:02:19	23:32:19	36.22	52.92	15	mb:4.6	BE	North-West of Pol-E-Sefid, Mazand..
67	11/6/1975	4:09:32	7:39:32	35.99	53.14	6	mb:4.6	ISC	South of Pol-E-Sefid, Mazandaran P.
68	5/2/1977	15:17:49	18:47:49	36.99	55.26	15	mb:5.1	BE	East of Ramian, Golestan Province
69	11/9/1977	11:20:33	14:50:33	36.7	54.99	33	mb:4.9	ISC	North of Shahrud, Semnan Province
70	3/2/1978	11:42:16	15:12:16	37.18	54.46	58	mb:4.6	ISC	North of Aq Qaleh, Golestan
71	8/9/1981	13:08:16	16:38:16	36.85	55.21	15	mb:4.9	BE	South of Ramian, Golestan Province
72	2/5/1982	23:37:12	3:07:12	36.12	53.67	33	mb:4.5	ISC	East of Pol-E-Sefid, Mazandaran P.
73	5/15/1982	17:36:08	21:06:08	35.47	54.07	15	mb:4.5	BE	East of Semnan, Semnan Province
74	5/11/1984	9:58:51	13:28:51	36.61	54.93	25	mb:4.9	BE	North of Shahrud, Semnan Province
75	7/8/1985	17:02:35	20:32:35	36.27	53.71	33	mb:4.7	ISC	South-East of Behshahr, Mazand.. .

76	10/29/1985	13:13:41	16:43:41	36.68	54.77	15	Mw:6.1	BE	South of Ali Abad, Golestan
77	10/29/1985	13:42:13	17:12:13	36.51	54.73	60	mb:4.6	ISC	West of Shahrud, Semnan Province
78	10/29/1985	13:49:20	17:19:20	36.58	54.59	33	mb:4.7	ISC	South-East of Gorgan, Golestan P.
79	10/29/1985	14:23:05	17:53:05	36.9	54.89	13	Mw:6.2	BE	Ali Abad, Golestan Province
80	11/6/1985	19:47:58	23:17:58	36.69	54.62	54	mb:4.5	ISC	South-East of Gorgan, Golestan P.
81	11/24/1985	17:22:35	20:52:35	36.9	54.88		mb:4.7	ISC	Ali Abad, Golestan Province
82	3/26/1986	15:18:09	18:48:09	36.01	53.67	34	mb:4.6	ISC	South-East of Pol-E-Sefid, Mazand..
83	1/13/1988	5:56:57	9:26:57	37.27	54.39	15	mb:4.9	BE	North of Aq Qaleh, Golestan
84	9/13/1989	7:01:32	10:31:32	37.24	54.22	30	mb:5.1	BE	North-West of Aq Qaleh, Golestan P.
85	1/20/1990	1:27:12	4:57:12	35.9	52.97	30	Mw:6	BE	South of Pol-E-Sefid, Mazandaran P.
86	1/20/1990	2:15:07	5:45:07	35.98	53.29	42	mb:4.6	ISC	South-East of Pol-E-Sefid, Mazand..
87	2/16/1990	5:55:06	9:25:06	35.91	54.55	25	mb:4.8	BE	South-East of Damghan, Semnan P.
88	4/21/1990	21:57:52	1:27:52	36.12	53.09	28	mb:4.5	ISC	Pol-E-Sefid, Mazandaran P.
89	5/29/1991	15:15:21	19:45:21	36.23	53.23	33	mb:4.5	ISC	North-East of Pol-E-Sefid, Mazand..
90	8/23/1991	22:14:21	2:44:21	35.99	53.27	42	mb:5	ISC	South-East of Pol-E-Sefid, Mazand..
91	9/9/1992	17:12:57	21:42:57	36.96	55.23	15	mb:4.9	BE	Ramian, Golestan P.
92	9/22/1992	14:05:56	17:35:56	36.29	52.72	35	mb:5.1	BE	South-West of Qaemshahr, Mazand..
93	6/19/1993	17:01:55	21:31:55	36.74	54.82	15	mb:4.5	BE	South of Ali Abad, Golestan P.
94	6/30/1993	23:05:37	3:35:37	35.17	53.55	25	mb:4.6	BE	South-East of Semnan, Semnan P.
95	7/13/1993	14:22:54	18:52:54	37.01	55.3	26	mb:4.6	ISC	East of Ramian, Golestan P.
96	10/18/1993	1:28:24	4:58:24	36.54	53.77	33	mb:4.5	ISC	South-East of Behshahr, Mazand..
97	6/4/1994	10:38:57	15:08:57	36.71	54.76	53	mb:4.7	ISC	South-West of Ali Abad, Golestan P.
98	7/11/1994	20:57:39	1:27:39	37.42	54.42	30	mb:4.7	BE	North of Aq Qaleh, Golestan P.
99	7/23/1994	7:08:15	11:38:15	37.32	54.34	30	mb:4.7	BE	North-West of Aq Qaleh, Golestan P.
100	2/17/1997	22:53:50	2:23:50	36.81	54.67	33	Mb:4.7	USGS	East of Gorgan, Golestan P.
101	8/26/1997	0:44:49	5:14:49	36.54	53.07	33	Mb:4.5	USGS	Sari, Mazandaran P.
102	9/16/1997	12:15:32	16:45:32	36.92	54.1	33	Mb:4.8	USGS	Bandar-e torkaman, Golestan P.
103	11/3/1997	6:59:30	10:29:30	36.33	54.46	33	Mb:4.8	USGS	North-East of Damghan, Semnan P.
104	3/13/1999	4:30:15	8:00:15	35.38	53.46	33	Mb:4.5	USGS	South of Semnan, Semnan P.
105	8/10/1999	19:33:59	0:03:59	36.24	54.65	33	Mb:4.5	USGS	East of Damghan, Semnan P.
106	11/19/1999	4:40:24	8:10:24	37.34	54.42	32	Mb:5.1	USGS	North of Aq Qaleh, Golestan P.
107	11/26/1999	4:27:24	7:57:24	36.84	54.82	33	Mb:5.2	USGS	Ali Abad, Golestan Province
108	12/9/1999	22:20:29	1:50:29	36.66	55.15	33	Mb:4.8	USGS	South of Ramian, Golestan P.
109	8/16/2000	12:52:46	17:22:46	36.59	54.56	33	ML:4.7	IIEES	South-East of Gorgan, Golestan P.
110	10/7/2004	21:46:15	1:16:15	37.35	54.56	15	ML:6	IIEES	North-East of Aq Qaleh, Golestan P.
111	10/8/2004	13:45:47	17:15:47	37.46	54.66	15	ML:4.9	IIEES	North-West of Gonbad-e kavus, Gol.
112	1/10/2005	18:47:25	22:17:25	37.38	54.58	15	ML:5.6	IIEES	North-East of Aq Qaleh, Golestan P.

*پیش لرزه و پس لرزه های حذف شده با توجه به زمان وقوع و فاصله.

*درمواردی که Ms گزارش شده بوسیله فرمول زیر تبدیل به Mw شده است. (Earthquake Risk Reduction, D.J.Dowrick) :

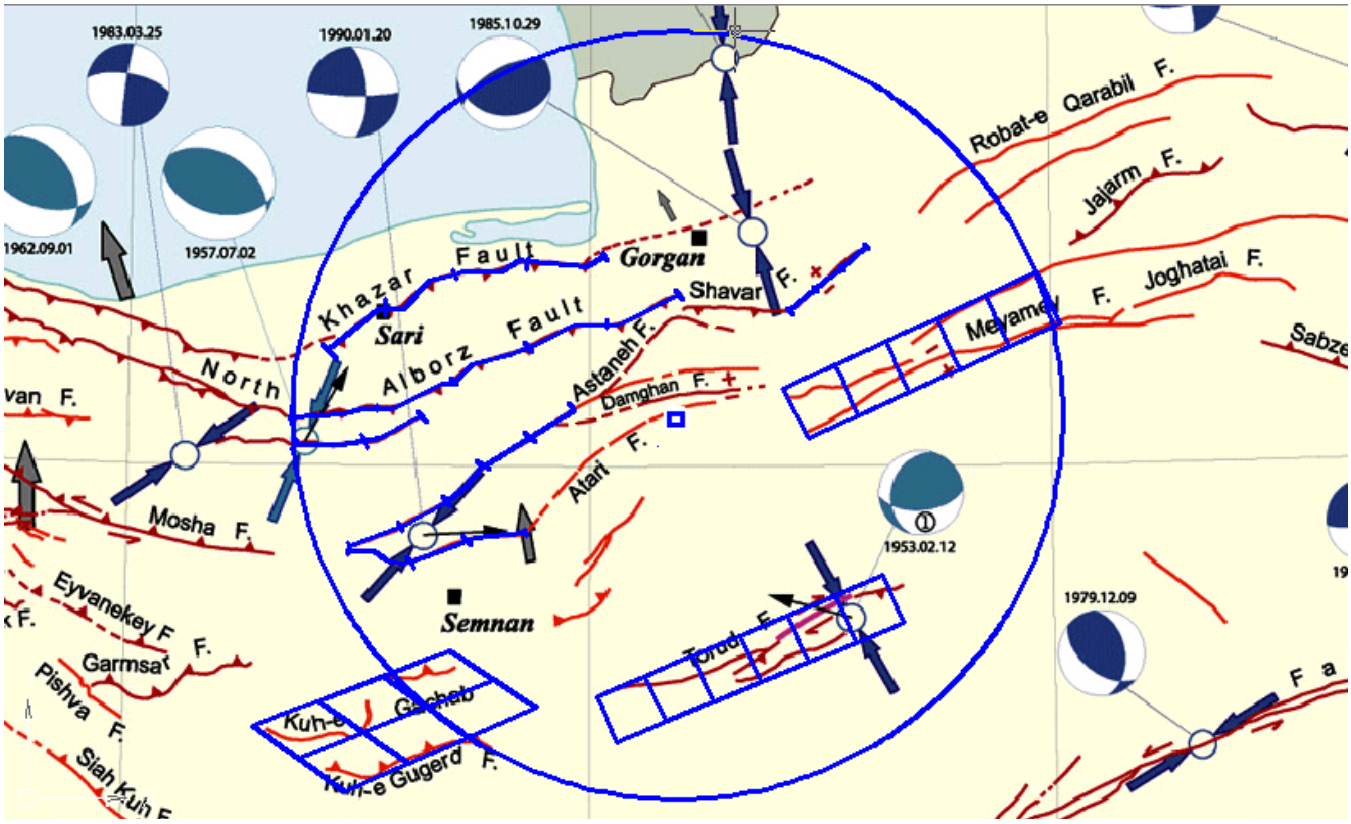
$$M_W = \begin{cases} 2.13 + \frac{2}{3}M_S & M_S < 5.3 \\ 9.40 - \sqrt{41.09 - 5.07M_S} & 5.3 \le M_S \le 6.8 \\ 0.03 + M_S & M_S > 6.8 \end{cases}$$

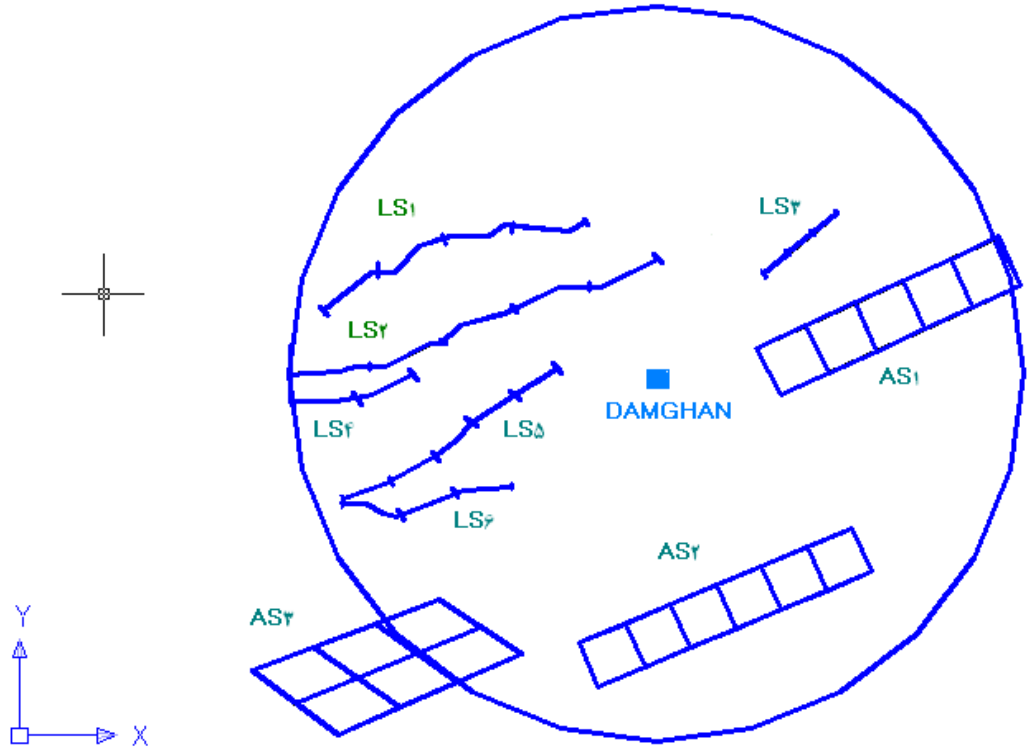
جهت بدست آوردن $Mmax$ برای هر چشمه علاوه بر بررسی زلزله های رخ داده ، می توان از فرمولهای پیشنهادی که بر مبنای طول گسل (L) تقریبی از $Mmax$ را میدهد استفاده کرد . در زیر به دو نمونه از آنها اشاره می شود که فرمول اول در این مجموعه بکار گرفته شده است.:

function1: Mw = 0.91 Ln (0.37 L) +3.66

function2: Mw = (Log(0.37L) +4.1)/0.804

محدوده منطقه مورد بررسی در شعاع ۱۵۰ کیلومتری شهر دامغان :





- خصوصیات چشمه های خطی(**LS1** تا **LS8**):

Line source 1 (LS1)

Total Length: 120 km
Minimum distance from site R_{min} = 66.8 km
Length of each segment: 30 km
Maximum Magnitude in database= 6.2
Maximum Magnitude in **function**= **0.91 Ln (0.37 L)+3.66**=7.1
M (max) =6.8

Segment 1= 30 km , R_{11}=73.3 km

Segment 2= 30 km , R_{12}=92.1 km

Segment 3= 30 km , R_{13}=111.8 km

Segment 4= 30 km , R_{14}=128.0 km

Line source 2 (LS2)

Total Length: 160 km
Minimum distance from site R_{min} = 42.5 km
Length of each segment: 32 km
Maximum Magnitude in database= 6.8
Maximum Magnitude in function= 7.4
M (max) =۶,۸

Segment 1=32 km , R_1=43.0 km

Segment 2= 32 km , R_2=54.8 km

Segment 3= 32 km , R_3=77.3 km

Segment 4= 32 km , R_4=101.0 km

Segment 5= 32 km , R_5=132.7 km

Line source 3 (LS3)

Total Length: 39 km
Minimum distance from site R_{min} = 61.4 km
Length of each segment: 13 km
Maximum Magnitude in database= 6.1
Maximum Magnitude in function= 6
M (max)=6.1

Segment 1= 13 km , R_1=68.9 km

Segment 2= 13 km , R_2=82.0 km

Segment 3= 13 km , R_3=94.5 km

Line source 4 (LS4)

Total Length:50 km
Minimum distance from site R_{min} = 98.2 km
Length of each segment: 25 km
Maximum Magnitude in database=6.8
Maximum Magnitude in function= 6.3
M (max)=6.8
Segment 1: 25 km , R_1=136.1 km

Segment 2: 25 km , R_2=109.6 km

Line source 5 (LS5)

Total Length: 100 km
Minimum distance from site R_{min} = 39 km
Length of each segment: 20 km
Maximum Magnitude in database= 6
Maximum Magnitude in function= 6.9
M (max) =6.8

Segment 1: 20 km , R_1=47.6 km

Segment 2: 20 km , R_2=66.1 km

Segment 3: 20 km , R_3=85 km

Segment 4: 20 km , R_4=104.5 km

Segment 5: 20 km , R_5=125.2 km

Line source 6 (LS6)

Total Length: 75 km
Minimum distance from site R_{min} = 73.2 km
Length of each segment: 25 km
Maximum Magnitude in database= 6
Maximum Magnitude in function= 6.7
M (max) =6.5
Segment 1: 25 km , R_{11}=83.8 km

Segment 2: 25 km , R_{12}=106.1 km

Segment 3: 25 km , R_{13}=126.5 km

- **خصوصیات چشمه های سطحی(AS1 تا AS4):**

Area source 1 (AS1)

Total area : 2205 km^2
Minimum distance from site R_{min} = 43.6 km
Maximum Magnitude in database= 5.7
Maximum Magnitude in function= 6.9
M (max)=6

Specifications of each sub-area:
Sub-area 1: A_1 = 441 km^2 R_{41}=57.4 Km
Sub-area 2: A_2 = 441 km^2 R_{42}=78.5 Km
Sub-area 3: A_3 = 441 km^2 R_{43}=100 Km
Sub-area 4: A_4 = 441 km^2 R_{44}=120.9 Km
Sub-area 5: A_5 = 441 km^2 R_{44}=142.1 Km

Area source 2 (AS2)

Total area : 2400 km^2
Minimum distance from site R_{min} = 88.1 km
Maximum Magnitude in database=6.9
Maximum Magnitude in function=7.1
M (max)=6.9

Specifications of each sub-area:
Sub-area 1: A_1 = 400 km^2 R_1=106.2 Km
Sub-area 2: A_2 = 400 km^2 R_2=100.3 Km
Sub-area 3: A_3 = 400 km^2 R_3=98 Km
Sub-area 4: A_5 = 400 km^2 R_4=99.9 Km
Sub-area 5: A_6 = 400 km^2 R_5=105.6 Km

Sub-area 6: A_7 = 400 km^2 R_6=114.5 Km

Area source 3 (AS3)

Total area : 3264 km^2
Minimum distance from site R_{min} = 124.3 km
Maximum Magnitude in database= 6.8
Maximum Magnitude in function= 6.8
M (max)=6.8

Specifications of each sub-area:
Sub-area 1: A_1 = 544 km^2 R_1=135.7 Km
Sub-area 2: A_2 = 544 km^2 R_2=136.8 Km
Sub-area 3: A_3 = 544 km^2 R_3=159.3 Km
Sub-area 4: A_4 = 544 km^2 R_4=161.7 Km
Sub-area 5: A_5 = 544 km^2 R_5=182.4 Km
Sub-area 6: A_6 = 544 km^2 R_6=186.8 Km

Attenuation expression for Iran (Zare, Bard, Ghafury-Ashtiany _1999):

$$\mathbf{Log\ PGA = a*Mw + b*R - d*Log\ R + Ci*Si + \sigma*p}$$

Horizontal: D=1 , p=0 or 1 , σ=0.394, a=0.322 , b=0.0004 , C1= -0.688

Vertical: D=1 , p=0 or 1 , σ=0.352 , a=0.322 , b=0.0003 , C2= -0.828

- در روش تعینی (**DSHA**) با توجه به مقادیر تعیین شده ی بزرگا و فاصله برای هر چشمه ، **PGA**بصورت زیر محاسبه می شود:

source	Rmin (KM)	M	PGA (Horizontal)	PGA (Vertical)	PGA,withσ (Horizontal)	PGA,withσ (Vertical)
LS1	66.8	6.8	0.04g	0.03g	0.11g	0.8g
LS2	42.5	6.8	0.07g	0.05g	0.18g	0.12g
LS3	61.4	6.1	0.03g	0.02g	0.07g	0.05g
LS4	98.2	6.8	0.03g	0.02g	0.07g	0.05g
LS5	39	6.8	0.08g	0.06g	0.20g	0.13g
LS6	73.2	6.5	0.03g	0.02g	0.08g	0.05g
AS1	43.6	6	0.04g	0.03g	0.10g	0.06g
AS2	88.1	6.9	0.04g	0.03g	0.09g	0.06g
AS3	124.3	6.8	0.02g	0.02g	0.06g	0.04g

- چنانچه بخواهیم در قضاوت ،حد اکثر مقادیر را به عنوان نتیجه تحلیل انتخاب کنیم داریم :

PGA(H)=0.2۰g

PGA(V)=0.۱۳g

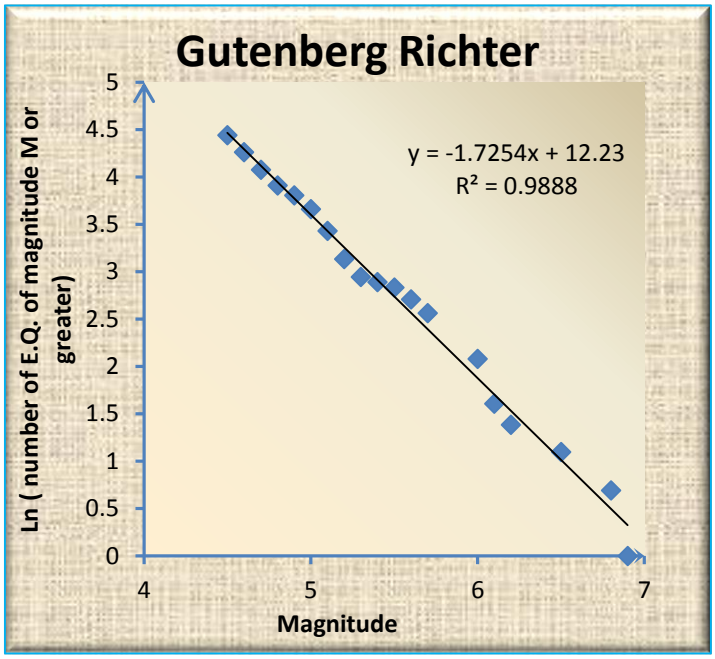
- **در روش احتمالاتی (PSHA) طیف خطر زلزله به شرح زیر محاسبه می شود:**

خصوصیات چشمه های مورد نظر وتقسیم بندی آنها:

source	تقسیمات تعداد L_i	L(km) or A(km2)	ΔL(km) or ΔA(km2)	F(R)*ΔR
LS1	4	120	30	1/4
LS2	5	160	32	1/5
LS۳	3	39	13	1/3
LS۴	2	50	25	1/2
LS۵	۵	۱۰0	20	1/۵
LS۶	3	75	25	1/3
AS1	5	2205	441	1/5
AS۲	6	2400	400	1/6
AS۳	6	3264	544	1/6

تابع چگالی احتمال:

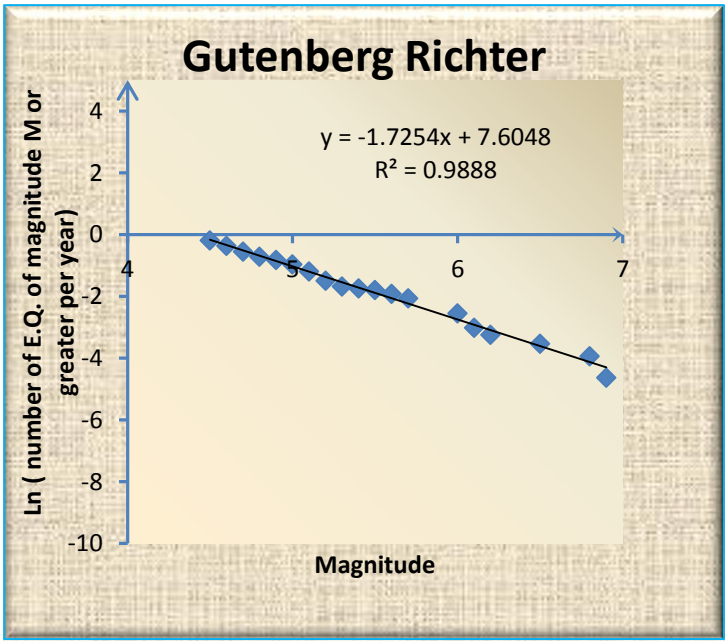
رابطه گوتنبرگ ریشتر:



نمودار بالا $Ln(N)$ را بر حسب M نشان می دهد که حاصل رگرسیون آن رابطه $y = -1.725x + 12.23$ است .

$$N = e^{-1.725M+12.23}$$

اگر بخواهیم برای N در سال نشان دهیم داریم :



ملاحظه می شود که در مقدارß تغییری نداریم و تنها ∝ عوض شد.

همینطور می توان N در سال در طول چشمه یا در سطح چشمه را داشت البته باید در بدست آوردن μ دقت شود که دوباره این مقادیر ضرب می شود:

با توجه به در نظر گرفتن یک رابطه گوتنبرگ ریشتر برای کل منطقه داریم:

Mo=4.5 , M max=۷

Average Rate of occurrence:

ν=N(4.5)-N(7)=87.13860394-1.67657961 = 85.97 = 0.84 per year

ν=N/y(4.5)-N/y(7)=0.853-0.011 = 0.84

$$F(M) = c1 * \beta1 * e^{-\beta1(M-m0)}$$

$$c = \frac{1}{1-e^{-\beta1(Mmax-Mo)}} = \frac{1}{1-e^{-1.725(7-4.5)}} = 1.01$$

- **تابع احتمال :**

$$F(M) = 1.01 * 1.725 * e^{-1.725(M-4.5)}$$

$$F(M) = 1.74 * e^{-1.725(M-4.5)}$$

$\Delta M = ۰,۵$

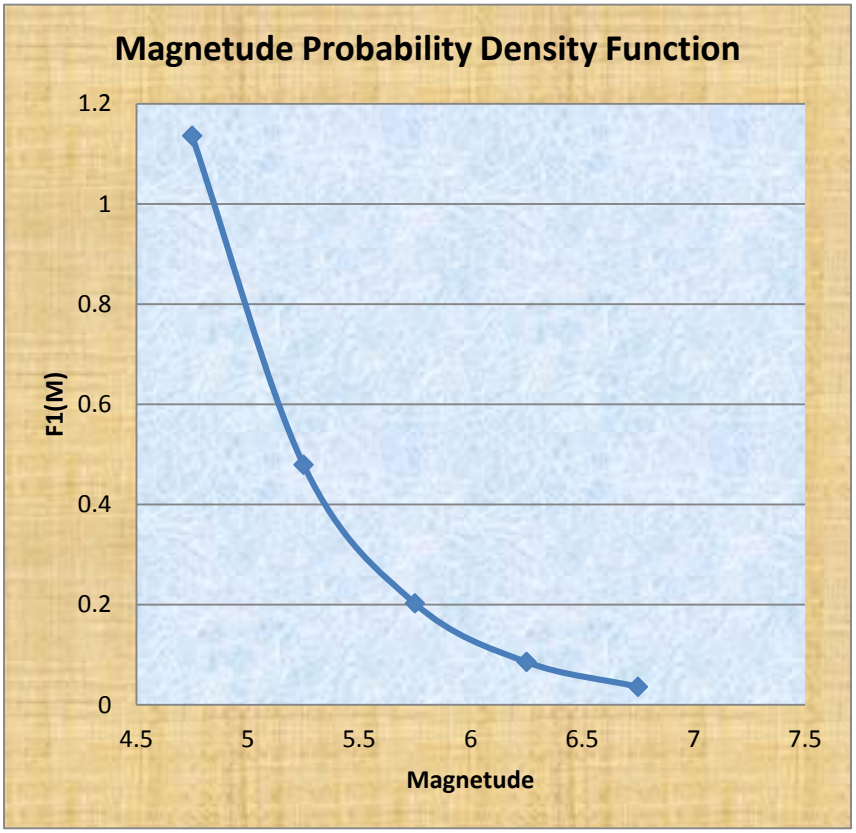
$4.5 < M < 5.0$	$M_{mid0}=4.75$
$5.0 < M < 5.5$	$M_{mid1}=5.25$
$5.5 < M < 6.0$	$M_{mid2}=5.75$
$6.0 < M < 6.5$	$M_{mid3}=6.25$
$6.5 < M < 7.0$	$M_{mid4}=6.75$

P (Mmidi – ΔM/2 < M < Mmidi – ΔM/2) = f1(M midi). ΔM

$$P\,(4.5 < M < 5 \mid EQ) = f\,1\,(M\,mid0) * \Delta M = f\,1\,(4.75) * 0.5 = 1.802 * e^{-1.725\,(4.75-4)} * 0.5 = 0.568$$

P (4.5 < M < 5.0 | EQ) = $f\,1\,(M\,mid0) * \Delta M$ =0.568
P (5.0 < M < 5.5 | EQ) = $f\,1\,(M\,mid1) * \Delta M$ =0.240
P (5.5 < M < 6.0 | EQ) = $f\,1\,(M\,mid2) * \Delta M$ =0.101
P (6.0 < M < 6.5 | EQ) = $f\,1\,(M\,mid3) * \Delta M$ =0.043
P (6.5 < M < 7.0 | EQ) = $f\,1\,(M\,mid4) * \Delta M$ =0.018

$$\sum_i f1(M_{mid\ i}) * \Delta m = 1.0$$



حال برای هر چشمه مراحل زیر را انجام می دهیم :

چشمه ۱ (LS1):

Ground motion estimation:

Attenuation expression for Iran (Zare, Bard, Ghafury-Ashtiany _1999):

$$\mathbf{Log\ PGA = a*Mw + b*R - d*Log\ R + Ci*Si + \sigma*p}$$

Horizontal: D=1 , p=0 or 1 , σ = 0.394 , a= 0.322 , b= - 0.0004 , C1=-0.688

Vertical: D=1 , p=0 or 1 , σ = 0.352 , a= 0.322 , b= - 0.0003 , C2=-0.828

جدول مقادیر کاهندگی چشمه LS ۱ برای مولفه افقی:

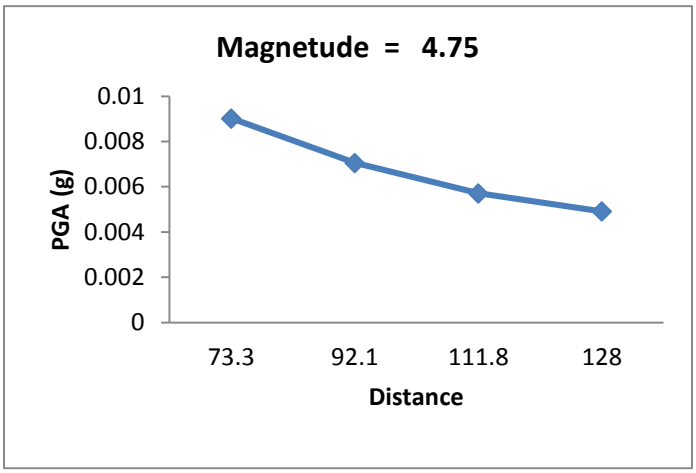
R(Km)	73.3		92.1		111.8		128	
(M mid)	Log (PGA)	PGA (g)	Log (PGA)	PGA (g)	Log (PGA)	PGA (g)	Log (PGA)	PGA (g)
4.75	-1.05292	0.009024	-1.1596	0.007059	-1.25166	0.00571	-1.31691	0.004914
5.25	-0.89192	0.013074	-0.9986	0.010227	-1.09066	0.008273	-1.15591	0.007119
5.75	-0.73092	0.018941	-0.8376	0.014816	-0.92966	0.011986	-0.99491	0.010314
6.25	-0.56992	0.027441	-0.6766	0.021465	-0.76866	0.017365	-0.83391	0.014942
6.75	-0.40892	0.039756	-0.5156	0.031098	-0.60766	0.025158	-0.67291	0.021648

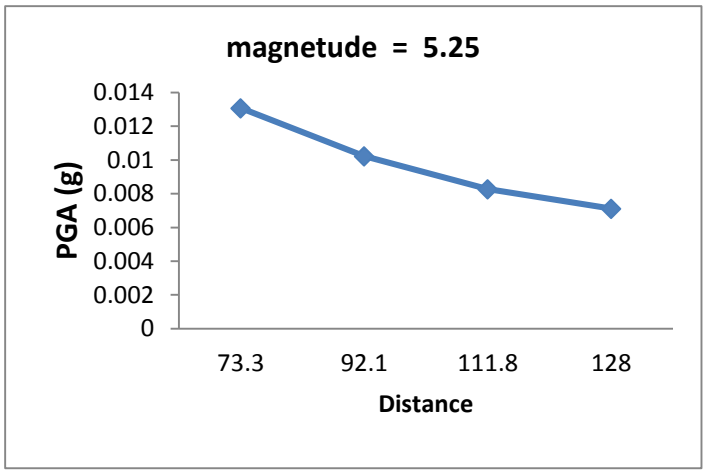
مولفه عمودی:

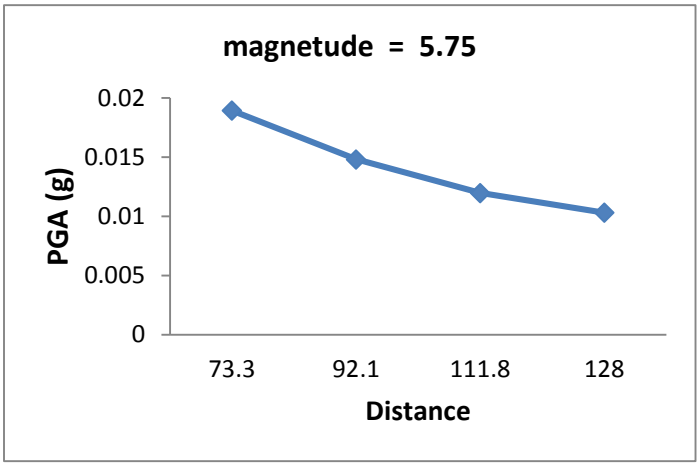
R (Km)	73.3		92.1		111.8		128	
(M mid)	Log (PGA)	PGA (g)	Log (PGA)	PGA (g)	Log (PGA)	PGA (g)	Log (PGA)	PGA (g)
4.75	-1.18559	0.006649	-1.29039	0.005223	-1.38048	0.004245	-1.44411	0.00367
5.25	-1.02459	0.009632	-1.12939	0.007567	-1.21948	0.00615	-1.28311	0.003666
5.75	-0.86359	0.013955	-0.96839	0.010963	-1.05848	0.008909	-1.12211	0.005312
6.25	-0.70259	0.020218	-0.80739	0.015883	-0.89748	0.012908	-0.96111	0.007695
6.75	-0.54159	0.029291	-0.64639	0.023011	-0.73648	0.0187	-0.80011	0.011149

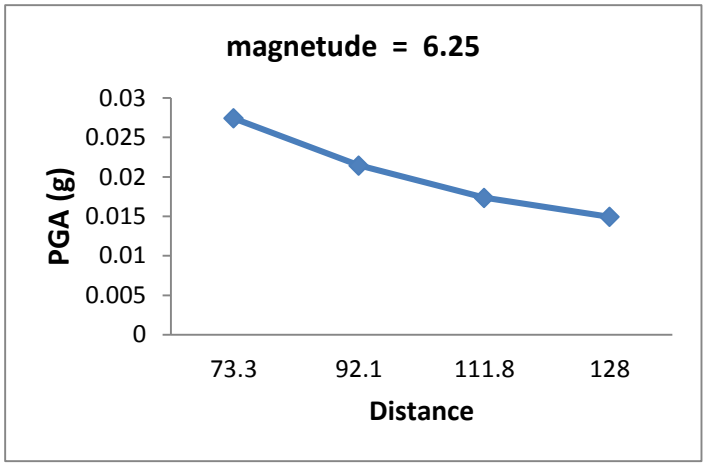
- با مقادیر مربوط به مؤلفه افقی محاسبات را ادامه می دهیم:

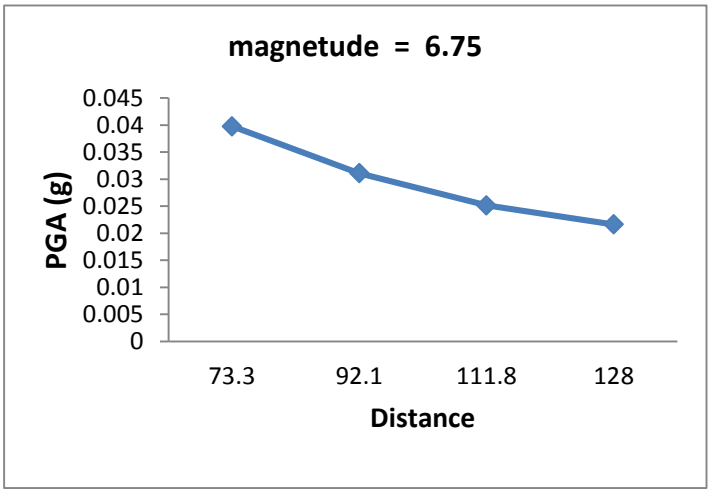
نمودار های مربوط به مولفه افقی بصورت زیر است











برای PGA بزرگتر از acceleration مشخص برای هر R و M با فرض اینکه acceleration در محدوده 0.05g تا 0.65g باشد حالات زیر را در نظر می گیریم:

acc0 = 0.05g
acc1 = 0.10g
acc2 = 0.15g
acc3 = 0.20g
.
.
.
acc12 = 0.65g

$$P(PGA > acc \mid EQ : R,M) = 1 - \emptyset\left[\frac{\{\log(acc) - \log(PGA)\}}{\sigma_{\log PGA}}\right]$$

. . . . . .

acc > 0.05g R=73.3km M=4.75

$$P(PGA > 0.05 \mid EQ : R = 73.3, M = 4.75) = 1 - \emptyset\left[\frac{\{\log(0.05) - \log(0.009024)\}}{0.394}\right]$$

$$= 1 - \emptyset\left(\frac{\{-1.301 + 2.045\}}{0.394}\right) = 1 - \emptyset(1.8873) = 1 - 0.97044 = 0.02956$$

P (PGA >	0.05	g		EQ : R,M)	
M	R (km)	R (Km)	R (Km)	R (km)	
(mid)	73.3	92.1	11.8	128	
4.75	0.02956566	0.015465234	0.008386953	0.005275458	
5.25	0.069625464	0.040116422	0.023683883	0.015833002	
5.75	0.142319373	0.090007766	0.05770125	0.040931964	
6.25	0.254201194	0.175648167	0.121860173	0.091538155	
6.75	0.400250822	0.30033115	0.224492381	0.178078355	

P (PGA >	0.1	g	| EQ : R,M)	
M	R (km)	R (Km)	R (Km)	R (km)
(mid)	73.3	92.1	11.8	128
4.75	0.004009708	0.001738949	0.000800672	0.00044805
5.25	0.012460607	0.005979155	0.003006859	0.001791955
5.75	0.033327566	0.017656854	0.009683174	0.006139771
6.25	0.077026163	0.044932213	0.026817446	0.018068697
6.75	0.154640123	0.098962847	0.064111829	0.045825844

P (PGA >	0.15	g	| EQ : R,M)	
M	R (km)	R (Km)	R (Km)	R (km)
(mid)	73.3	92.1	11.8	128
4.75	0.000973555	0.000377298	0.000157529	8.22149E-05
5.25	0.003577379	0.001536677	0.000701667	0.000390321
5.75	0.011276458	0.005360326	0.002673621	0.001584044
6.25	0.030582899	0.016054726	0.008734008	0.005506119
6.75	0.071642671	0.041422151	0.024529629	0.016434459

P (PGA >	0.2	g	| EQ : R,M)	
M	R (km)	R (Km)	R (Km)	R (km)
(mid)	73.3	92.1	11.8	128
4.75	0.000318574	0.000113887	4.43301E-05	2.20098E-05
5.25	0.001320687	0.000523825	0.000223155	0.000118148
5.75	0.004688044	0.002060303	0.000959667	0.000541469
6.25	0.014283947	0.006943971	0.00353203	0.002122125
6.75	0.0374751	0.020108197	0.011151146	0.007127269

P (PGA >	0.25	g	| EQ : R,M)	
M	R (km)	R (Km)	R (Km)	R (km)
(mid)	73.3	92.1	11.8	128
4.75	0.000125493	4.21207E-05	1.55225E-05	7.41271E-06
5.25	0.000571728	0.000213046	8.59701E-05	4.37925E-05
5.75	0.002227606	0.000920527	0.000406393	0.0002207
6.25	0.00743843	0.003403791	0.00164226	0.00095018
6.75	0.021344838	0.010795591	0.005684555	0.003501005

P (PGA >	0.3	g	| EQ : R,M)	
M	R (km)	R (Km)	R (Km)	R (km)
(mid)	73.3	92.1	11.8	128
4.75	5.61809E-05	1.79053E-05	6.30892E-06	2.91816E-06
5.25	0.000276589	9.79135E-05	3.779E-05	1.86494E-05
5.75	0.001163556	0.000457053	0.000193077	0.000101612
6.25	0.004190402	0.001824094	0.000842604	0.000472607
6.75	0.012950227	0.00623686	0.003146489	0.001879452

P (PGA >	0.35	g	| EQ : R,M)	
M	R (km)	R (Km)	R (Km)	R (km)
(mid)	73.3	92.1	11.8	128
4.75	2.76363E-05	8.42942E-06	2.85916E-06	1.28718E-06
5.25	0.000145319	4.92504E-05	1.83033E-05	8.79311E-06
5.75	0.000652505	0.000245493	9.98932E-05	5.11879E-05
6.25	0.002506119	0.001045488	0.000465386	0.000254228
6.75	0.008251059	0.003811045	0.00185378	0.001078811

P (PGA >	0.4	g	| EQ : R,M)	
M	R (km)	R (Km)	R (Km)	R (km)
(mid)	73.3	92.1	11.8	128
4.75	1.4619E-05	4.29206E-06	1.40848E-06	6.19372E-07
5.25	8.13975E-05	2.65616E-05	9.55242E-06	4.48317E-06
5.75	0.000386812	0.000140174	5.52101E-05	2.76428E-05
6.25	0.001571299	0.00063166	0.000272258	0.00014535
6.75	0.005466947	0.002434654	0.0011472	0.000652632

P (PGA >	0.45	g	| EQ : R,M)	
M	R (km)	R (Km)	R (Km)	R (km)
(mid)	73.3	92.1	11.8	128
4.75	8.19412E-06	2.32598E-06	7.41319E-07	3.19294E-07
5.25	4.79928E-05	1.51452E-05	5.29085E-06	2.43238E-06
5.75	0.000239806	8.40637E-05	3.21697E-05	1.578E-05
6.25	0.001023722	0.000398243	0.000166821	8.72686E-05
6.75	0.003740552	0.001612772	0.000738808	0.000411935

P (PGA >	0.5	g	| EQ : R,M)	
M	R (km)	R (Km)	R (Km)	R (km)
(mid)	73.3	92.1	11.8	128
4.75	4.81571E-06	1.32629E-06	4.11785E-07	1.74093E-07
5.25	2.95147E-05	9.03852E-06	3.07642E-06	1.38841E-06
5.75	0.000154267	5.24912E-05	1.95751E-05	9.42718E-06
6.25	0.000688573	0.000260085	0.000106193	5.45487E-05
6.75	0.002629149	0.001101084	0.000491794	0.000269302

P (PGA >	0.55	g	| EQ : R,M)	
M	R (km)	R (Km)	R (Km)	R (km)
(mid)	73.3	92.1	111.8	128
4.75	2.94438E-06	7.89003E-07	2.3923E-07	9.94517E-08
5.25	1.88031E-05	5.60363E-06	1.86285E-06	8.26746E-07
5.75	0.000102374	3.39059E-05	1.23515E-05	5.8501E-06
6.25	0.000475805	0.000174976	6.98026E-05	3.52679E-05
6.75	0.001890807	0.000771223	0.000336637	0.000181345

P (PGA >	0.6	g	| EQ : R,M)	
M	R (km)	R (Km)	R (Km)	R (km)
(mid)	73.3	92.1	11.8	128
4.75	1.86169E-06	4.86542E-07	1.4436E-07	5.90961E-08
5.25	1.23445E-05	3.58842E-06	1.16748E-06	5.10259E-07
5.75	6.97662E-05	2.25425E-05	8.03792E-06	3.74949E-06
6.25	0.000336478	0.000120747	4.71562E-05	2.34681E-05
6.75	0.001386977	0.000552196	0.000236014	0.000125248

P (PGA >	0.65	g	| EQ : R,M)	
M	R (km)	R (Km)	R (Km)	R (km)
(mid)	73.3	92.1	11.8	128
4.75	1.21163E-06	3.09435E-07	8.99975E-08	3.63235E-08
5.25	8.31715E-06	2.36292E-06	7.53654E-07	3.24778E-07
5.75	4.86508E-05	1.53659E-05	5.37191E-06	2.47095E-06
6.25	0.000242783	8.51793E-05	3.26205E-05	1.60095E-05
6.75	0.001035123	0.000403015	0.000168942	8.84241E-05

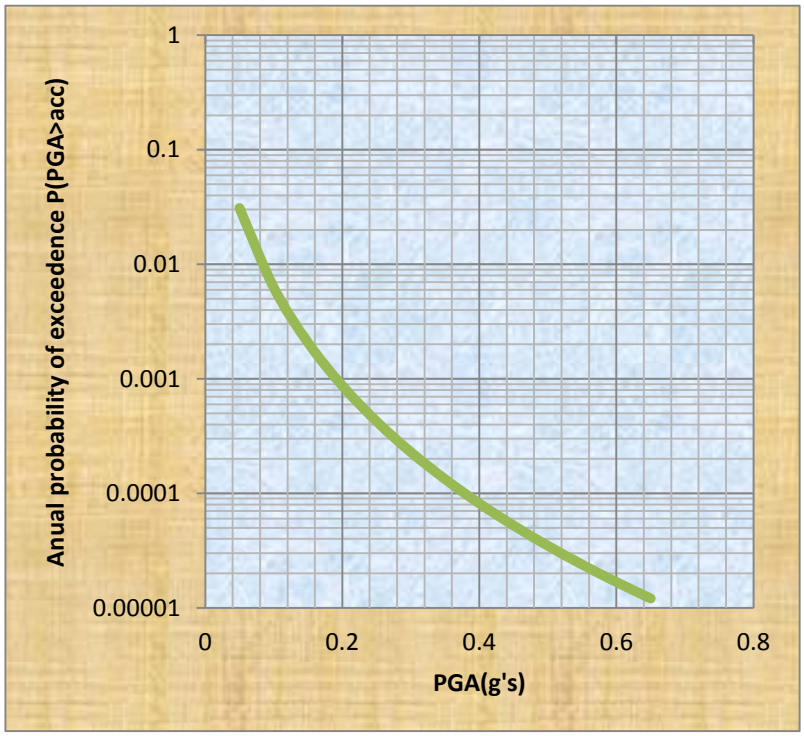
- محاسبه تابع احتمال برای وقوع زلزله بزرگتر از هر**acc** :

$$P(PGA > acc \mid EQ) = \sum_M \sum_R P(PGA > acc \mid EQ: M, R).f(R).f(M).\Delta M.\Delta R$$

$$P(PGA > acc) = 1 - e^{-\nu P}$$

$$\text{approx}: P(PGA > acc) = \nu p$$

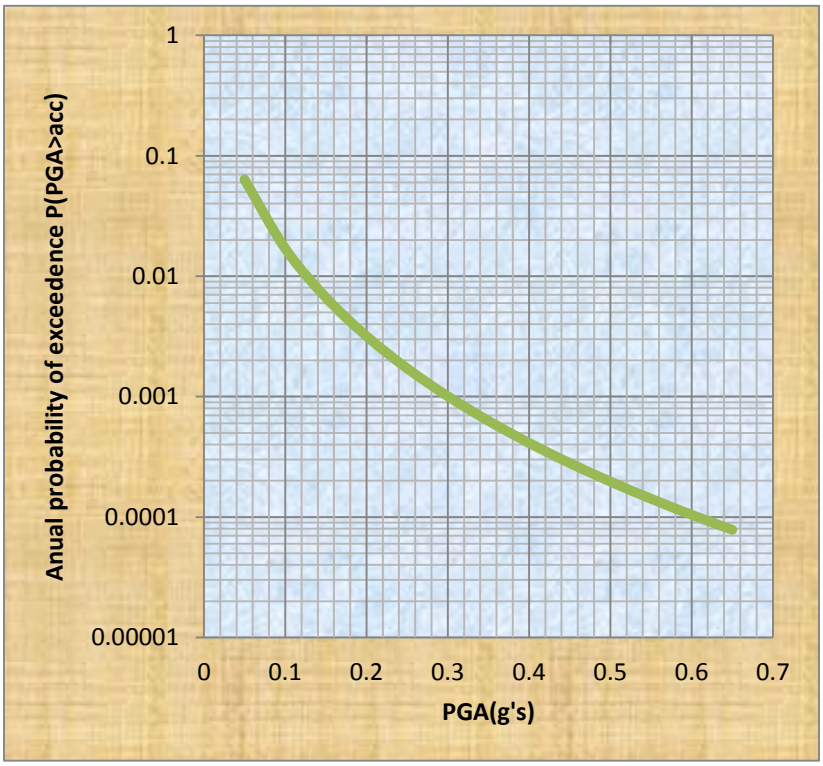
acc	P(PGA>acc/EQ)	P(PGA>acc)	P(PGA>acc) approx
0.05	0.037525824	0.03103006	0.031521692
0.1	0.00750434	0.00628382	0.006303645
0.15	0.002473378	0.00207548	0.002077637
0.2	0.001040638	0.00087375	0.000874136
0.25	0.000507644	0.00042633	0.000426421
0.3	0.000273801	0.00022997	0.000229993
0.35	0.000158891	0.00013346	0.000133468
0.4	9.7519E-05	8.1913E-05	8.19159E-05
0.45	6.25705E-05	5.2558E-05	5.25592E-05
0.5	4.16264E-05	3.4966E-05	3.49662E-05
0.55	2.85401E-05	2.3973E-05	2.39737E-05
0.6	2.00737E-05	1.6862E-05	1.68619E-05
0.65	1.4432E-05	1.2123E-05	1.21229E-05



چشمه 2 (LS2):

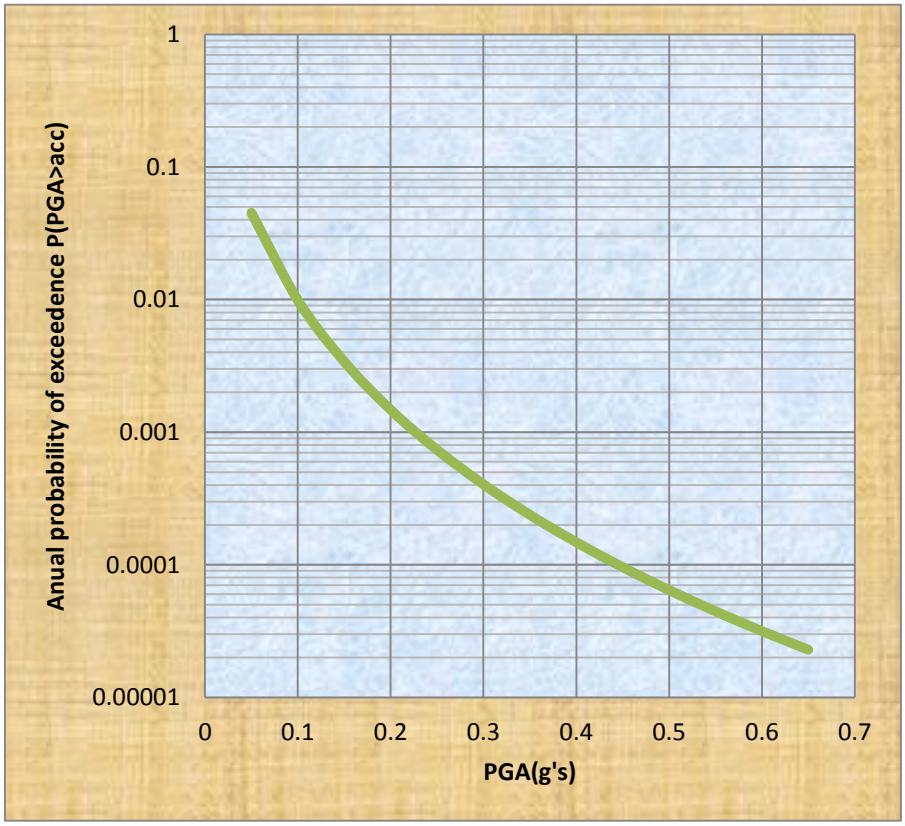
برای پرهیز از زیاد شدن حجم گزارش حاضر، در مورد بقیه چشمه ها ، اطلاعات به صورت فشرده تر ارائه می شود که پرونده های مربوط به جزئیات آنها در CD پیوست موجود است.

acc	P(PGA>acc/EQ)	P(PGA>acc)	P(PGA>acc) approx
0.05g	0.078488869	0.063804212	0.06593065
0.1g	0.020485969	0.017060998	0.017208214
0.15g	0.007975849	0.00667732	0.006699713
0.2g	0.003798481	0.003185639	0.003190724
0.25g	0.002047646	0.001718544	0.001720023
0.3g	0.001201517	0.001008765	0.001009274
0.35g	0.000750209	0.000629977	0.000630175
0.4g	0.000491301	0.000412608	0.000412693
0.45g	0.000334178	0.00028067	0.000280709
0.5g	0.000234448	0.000196917	0.000196936
0.55g	0.00016878	0.000141765	0.000141775
0.6g	0.000124193	0.000104317	0.000104322
0.65g	9.31206E-05	7.82182E-05	7.82213E-05



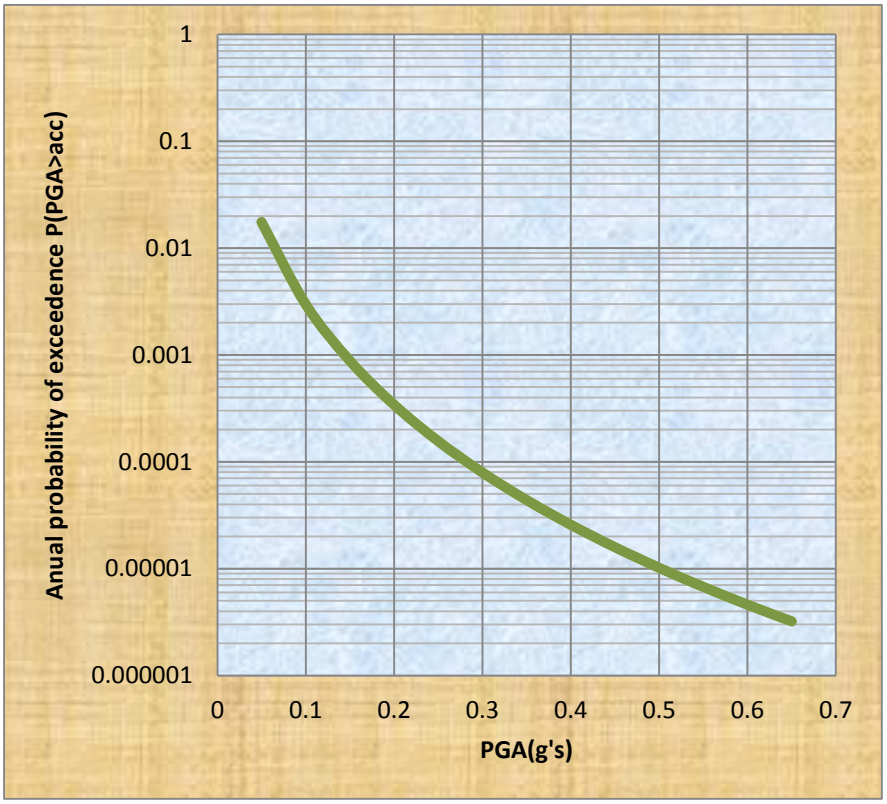
چشمه 3 (LS3):

acc	P(PGA>acc/EQ)	P(PGA>acc)	P(PGA>acc) approx
0.05g	0.054994567	0.04514467	0.046195437
0.1g	0.011841001	0.009897139	0.009946441
0.15g	0.004065797	0.003409444	0.003415269
0.2g	0.001759841	0.001477175	0.001478267
0.25g	0.0008773	0.00073666	0.000736932
0.3g	0.000481536	0.000404409	0.00040449
0.35g	0.000283569	0.00023817	0.000238198
0.4g	0.000176244	0.000148034	0.000148045
0.45g	0.000114334	9.60358E-05	9.60404E-05
0.5g	7.68097E-05	6.45181E-05	6.45202E-05
0.55g	5.31265E-05	4.46252E-05	4.46262E-05
0.6g	3.76647E-05	3.16379E-05	3.16384E-05
0.65g	2.72764E-05	2.29119E-05	2.29122E-05



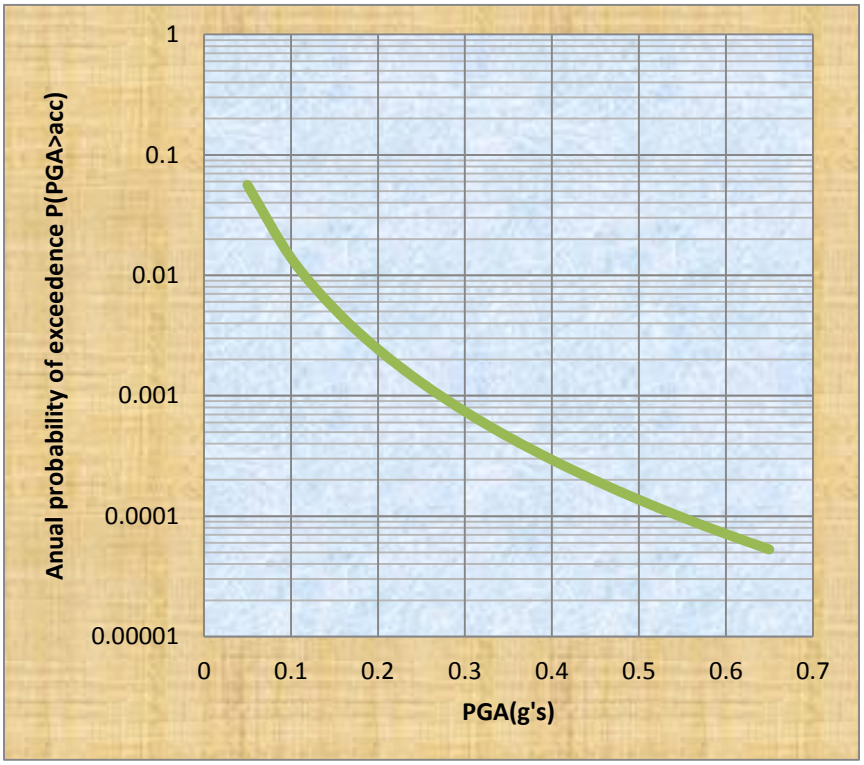
چشمه ۴ (LS4):

acc	P(PGA>acc/EQ)	P(PGA>acc)	P(PGA>acc) approx
0.05g	0.021066965	0.017540591	0.017696251
0.1g	0.003554266	0.002981131	0.002985584
0.15g	0.00105117	0.000882593	0.000882983
0.2g	0.000407422	0.000342176	0.000342235
0.25g	0.000185871	0.000156119	0.000156132
0.3g	9.46939E-05	7.95397E-05	7.95429E-05
0.35g	5.22795E-05	4.39138E-05	4.39147E-05
0.4g	3.06922E-05	2.57811E-05	2.57814E-05
0.45g	1.89181E-05	1.58911E-05	1.58912E-05
0.5g	1.21328E-05	1.01915E-05	1.01916E-05
0.55g	8.04249E-06	6.75567E-06	6.75569E-06
0.6g	5.48235E-06	4.60516E-06	4.60517E-06
0.65g	3.82807E-06	3.21558E-06	3.21558E-06



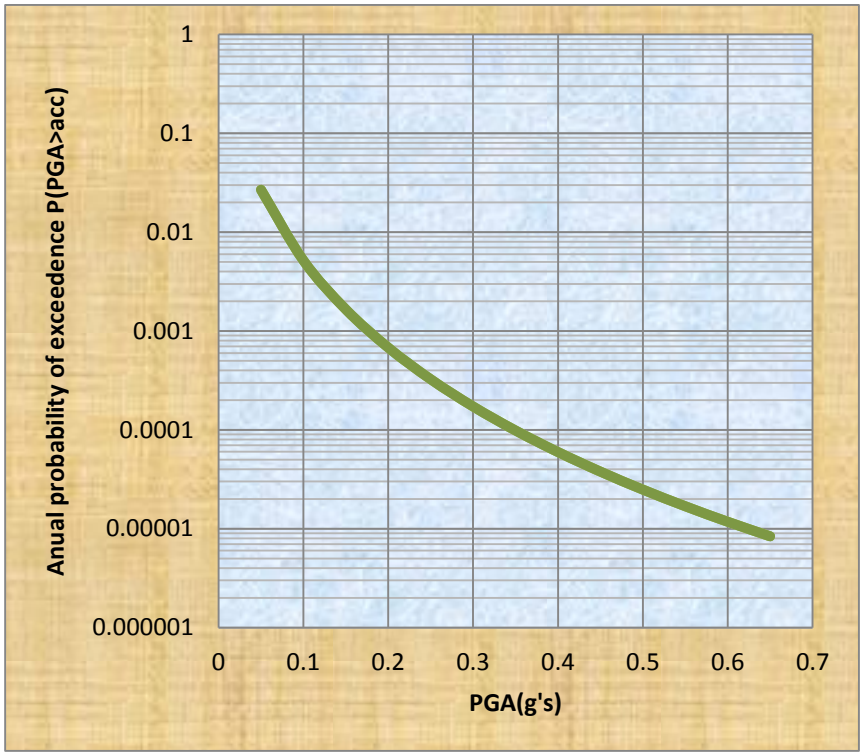
چشمه 5 (LS5):

acc	P(PGA>acc/EQ)	P(PGA>acc)	P(PGA>acc) approx
0.05g	0.068984787	0.056300247	0.057947221
0.10g	0.016798546	0.014011688	0.014110778
0.15g	0.006277361	0.005259105	0.005272983
0.20g	0.002903206	0.002435721	0.002438693
0.25g	0.001529568	0.001284012	0.001284837
0.30g	0.000880742	0.00073955	0.000739823
0.35g	0.000541157	0.000454469	0.000454572
0.40g	0.000349468	0.00029351	0.000293553
0.45g	0.000234771	0.000197188	0.000197208
0.50g	0.00016288	0.000136809	0.000136819
0.55g	0.000116075	9.74981E-05	9.75028E-05
0.60g	8.46214E-05	7.10795E-05	7.1082E-05
0.65g	6.29082E-05	5.28415E-05	5.28429E-05



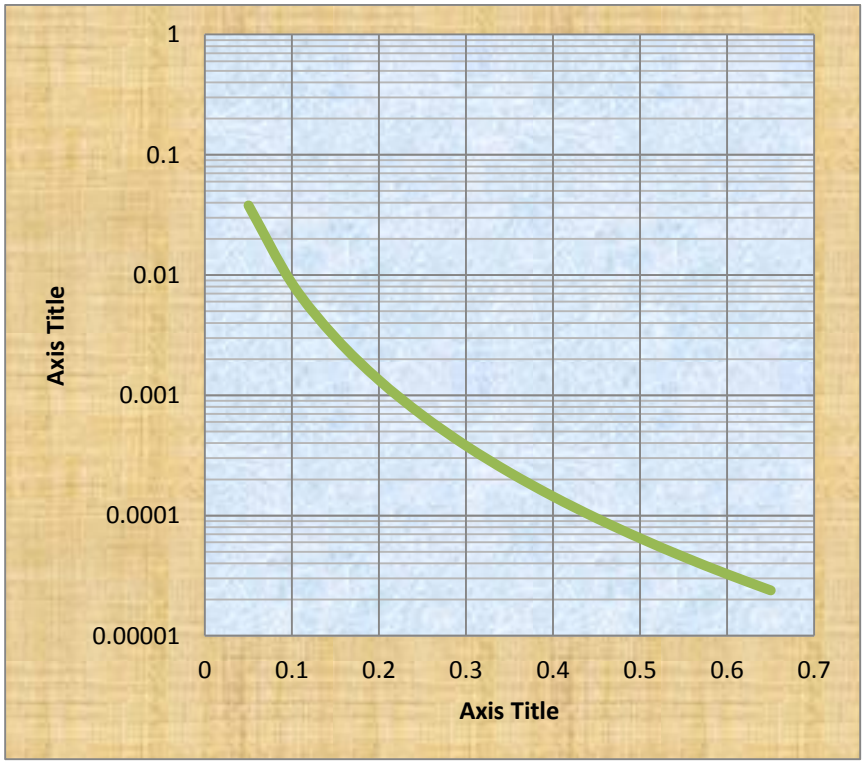
چشمه 6 (LS6):

acc	P(PGA>acc/EQ)	P(PGA>acc)	P(PGA>acc) approx
0.05g	0.032493506	0.026925415	0.027294545
0.10g	0.006180928	0.005178525	0.00519198
0.15g	0.001972153	0.001655237	0.001656608
0.20g	0.000809421	0.000679682	0.000679914
0.25g	0.000386877	0.000324924	0.000324977
0.30g	0.000205051	0.000172228	0.000172243
0.35g	0.000117181	9.84271E-05	9.84319E-05
0.40g	7.09381E-05	5.95862E-05	5.9588E-05
0.45g	4.4952E-05	3.7759E-05	3.77597E-05
0.50g	2.9566E-05	2.48351E-05	2.48354E-05
0.55g	2.00586E-05	1.68491E-05	1.68492E-05
0.60g	1.39706E-05	1.17352E-05	1.17353E-05
0.65g	9.95251E-06	8.36007E-06	8.36011E-06



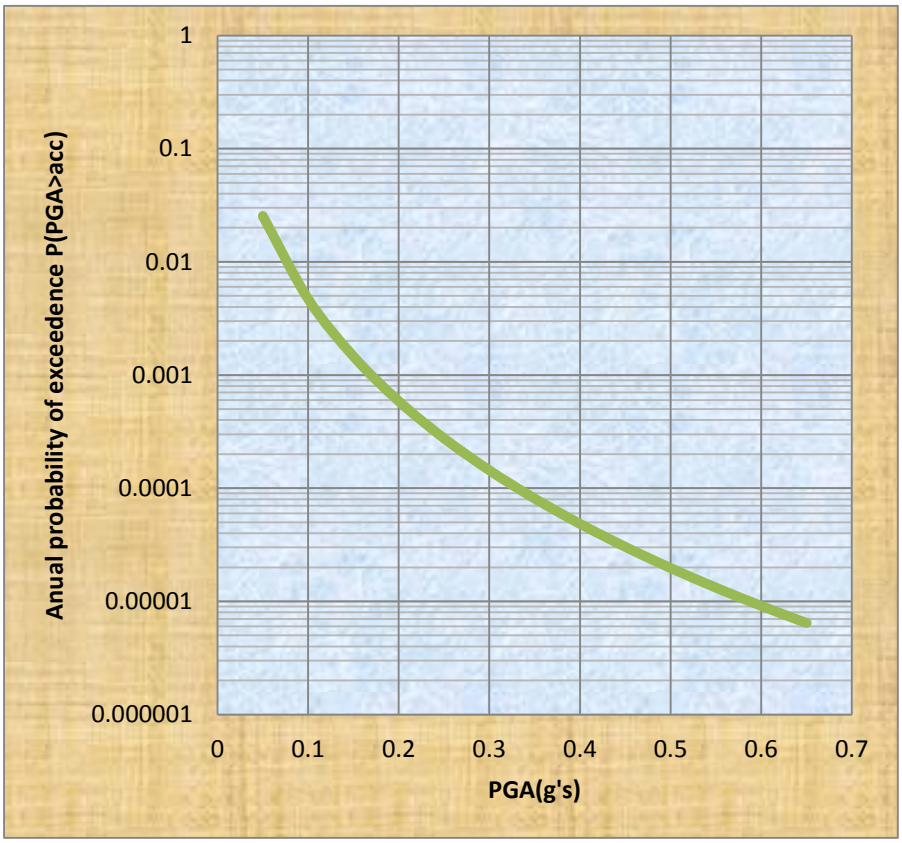
چشمه 7 (AS1):

acc	P(PGA>acc/EQ)	P(PGA>acc)	P(PGA>acc) approx
0.05g	0.046092479	0.037977733	0.038717682
0.1g	0.010196763	0.008528703	0.008565281
0.15g	0.003594078	0.003014473	0.003019025
0.2g	0.001592444	0.001336759	0.001337653
0.25g	0.000810722	0.000680775	0.000681006
0.3g	0.000453594	0.000380947	0.000381019
0.35g	0.000271858	0.000228334	0.00022836
0.4g	0.000171742	0.000144253	0.000144264
0.45g	0.00011312	9.50164E-05	9.5021E-05
0.5g	7.7085E-05	6.47493E-05	6.47514E-05
0.55g	5.4037E-05	4.53901E-05	4.53911E-05
0.6g	3.87992E-05	3.25908E-05	3.25913E-05
0.65g	2.84379E-05	2.38875E-05	2.38878E-05



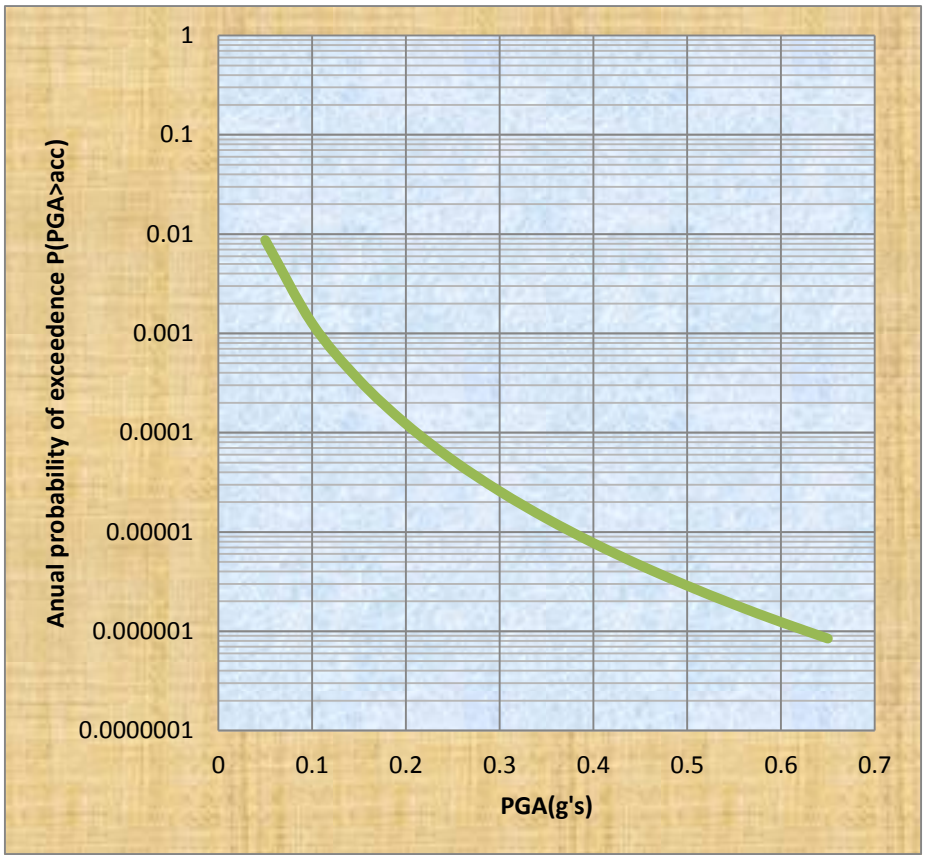
چشمه 8 (AS2):

acc	P(PGA>acc/EQ)	P(PGA>acc)	P(PGA>acc) approx
0.05g	0.030690782	0.025450784	0.025780257
0.1g	0.005617406	0.004707505	0.004718621
0.15g	0.001744118	0.001463986	0.001465059
0.2g	0.000700295	0.000588075	0.000588247
0.25g	0.000328523	0.000275921	0.00027596
0.3g	0.000171286	0.00014387	0.000143881
0.35g	9.64544E-05	8.10184E-05	8.10217E-05
0.4g	5.76137E-05	4.83943E-05	4.83955E-05
0.45g	3.60615E-05	3.02912E-05	3.02917E-05
0.5g	2.34491E-05	1.9697E-05	1.96972E-05
0.55g	1.574E-05	1.32215E-05	1.32216E-05
0.6g	1.08536E-05	9.11698E-06	9.11702E-06
0.65g	7.6594E-06	6.43388E-06	6.4339E-06



چشمه 9 (AS3):

acc	P(PGA>acc/EQ)	P(PGA>acc)	P(PGA>acc) approx
0.05g	0.010385003	0.008685464	0.008723403
0.1g	0.00150066	0.00125976	0.001260554
0.15g	0.000403536	0.000338913	0.000338971
0.2g	0.000145807	0.00012247	0.000122478
0.25g	6.28939E-05	5.28294E-05	5.28308E-05
0.3g	3.05764E-05	2.56839E-05	2.56842E-05
0.35g	1.62145E-05	1.36201E-05	1.36201E-05
0.4g	9.18822E-06	7.71807E-06	7.7181E-06
0.45g	5.48743E-06	4.60943E-06	4.60944E-06
0.5g	3.42032E-06	2.87307E-06	2.87307E-06
0.55g	2.20901E-06	1.85557E-06	1.85557E-06
0.6g	1.47024E-06	1.235E-06	1.235E-06
0.65g	1.00413E-06	8.43465E-07	8.43466E-07

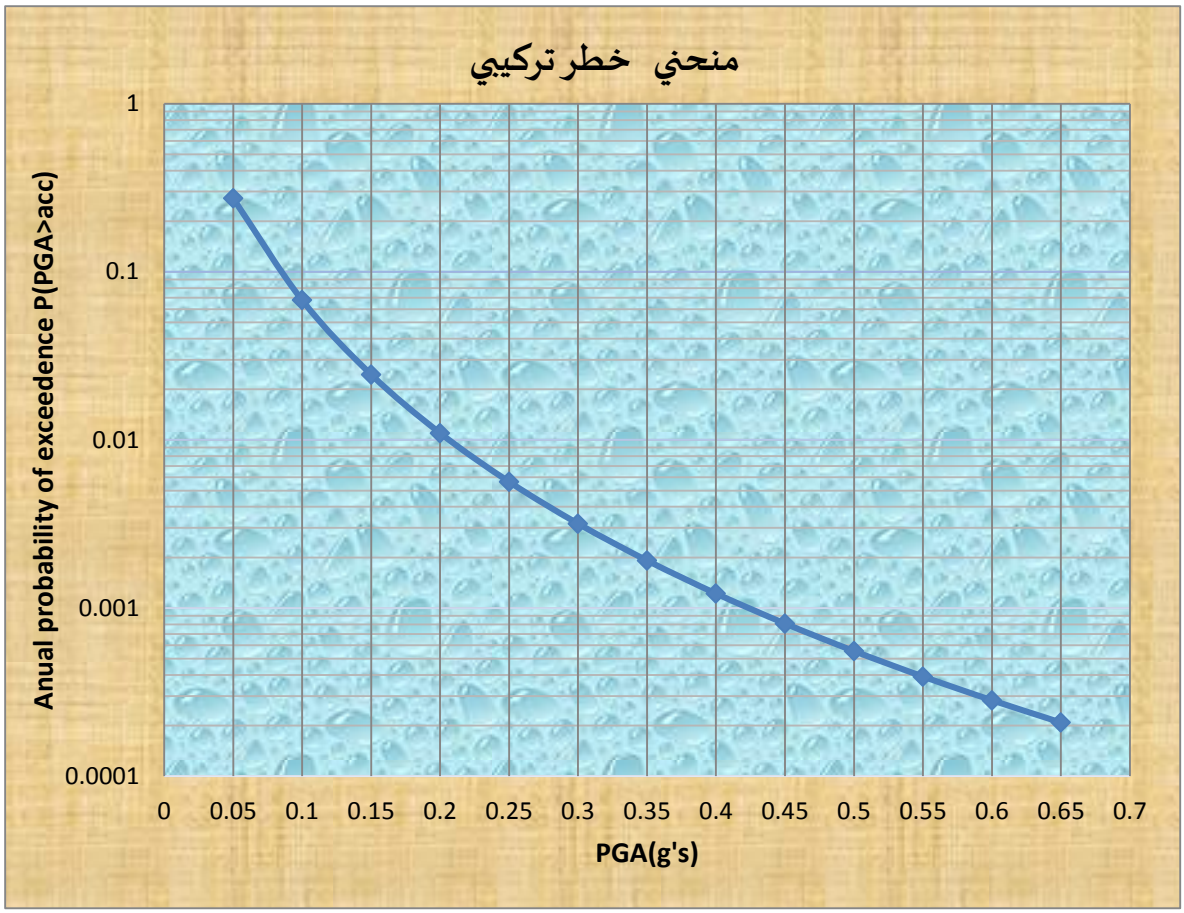


منحنی خطر ترکیبی:

$$P(PGA > acc) = 1 - \prod_k \{P(PGA < acc)_k\}$$

$$P(PGA > acc) = 1 - [\{1 - P(PGA > acc)_1\} \times \{1 - P(PGA > acc)_2\} \times \{1 - P(PGA > acc)_3\} \cdot \cdot \cdot \times \{1 - P(PGA > acc)_9\}]$$

	p(PGA>acc)									
acc	LS1	LS2	LS3	LS4	LS5	LS6	AS1	AS2	AS3	Combined value
0.05g	0.03103	0.063804	0.045145	0.017541	0.0563	0.026925	0.037978	0.025451	0.008685	0.2737109
0.1g	0.006284	0.017061	0.009897	0.002981	0.014012	0.005179	0.008529	0.004708	0.00126	0.0678776
0.15g	0.002075	0.006677	0.003409	0.000883	0.005259	0.001655	0.003014	0.001464	0.000339	0.0245226
0.2g	0.000874	0.003186	0.001477	0.000342	0.002436	0.00068	0.001337	0.000588	0.000122	0.0109915
0.25g	0.000426	0.001719	0.000737	0.000156	0.001284	0.000325	0.000681	0.000276	5.28E-05	0.0056431
0.3g	0.00023	0.001009	0.000404	7.95E-05	0.00074	0.000172	0.000381	0.000144	2.57E-05	0.0031809
0.35g	0.000133	0.00063	0.000238	4.39E-05	0.000454	9.84E-05	0.000228	8.1E-05	1.36E-05	0.0019199
0.4g	8.19E-05	0.000413	0.000148	2.58E-05	0.000294	5.96E-05	0.000144	4.84E-05	7.72E-06	0.0012212
0.45g	5.26E-05	0.000281	9.6E-05	1.59E-05	0.000197	3.78E-05	9.5E-05	3.03E-05	4.61E-06	0.0008098
0.5g	3.5E-05	0.000197	6.45E-05	1.02E-05	0.000137	2.48E-05	6.47E-05	1.97E-05	2.87E-06	0.0005554
0.55g	2.4E-05	0.000142	4.46E-05	6.76E-06	9.75E-05	1.68E-05	4.54E-05	1.32E-05	1.86E-06	0.0003919
0.6g	1.69E-05	0.000104	3.16E-05	4.61E-06	7.11E-05	1.17E-05	3.26E-05	9.12E-06	1.23E-06	0.0002831
0.65g	1.21E-05	7.82E-05	2.29E-05	3.22E-06	5.28E-05	8.36E-06	2.39E-05	6.43E-06	8.43E-07	0.0002088



- با توجه به احتمال وقوع زلزله در ۵۰ سال عمر مفید سازه ، که به ترتیب زیر محاسبه می شود ، می توان احتمال فراگذشت سالیانه (p) را بصورت زیر بدست آورد.
-

$$R_t = 1 - (1 - p)^t$$

$R_t = 0.02$ ⇒ P (2%) = 0.00040397

$R_t = 0.05$ ⇒ P (5%) = 0.00102534

$R_t = 0.10$ ⇒ P (10%) = 0.00210499

- و دوره بازگشت نیز معکوس مقادیر بالا است:

$$T_R(0.0004) = \frac{1}{0.00040397} = 2475 \text{ years}$$

$$T_R(0.001) = \frac{1}{0.00102534} = 975 \text{ years}$$

$$T_R(0.0004) = \frac{1}{0.00210499} = 475 \text{ years}$$

- بر طبق منحنی ترکیب شده خطر ، مقادیر PGA را برای احتمالات افزایش سالیانه محاسبه می کنیم :

P (0.0004) = ۰,۵۴ g
P (0.001) = ۰,۴۳ g
P (0.002) = ۰,۳۴ g

مشاهده می شود که برای سطح خطر ۱ با روش PSHA مقدار PGA=0.34g برای مؤلفه افقی بدست آمد که اگر بخواهیم با مقدار 0.2g روش DSHA مقایسه کنیم نتیجه می شود که مقدار دسته بالاتری بدست آمده است .البته قضاوت مهندسی است که می تواند منجر به انتخاب نهایی شود .

لازم به ذکر است که در آیین نامه ۲۸۰۰ برای شهر دامغان شتاب مبنای PGA=0.3g تعیین شده است ، که نسبتاً با تحلیل های انجام شده مطابقت می کند.

تدوین طیف طرح :

- **طیف طرح نیومارک- هال(۱۹۸۲) :**

با PGA=0.34g که از تحلیل خطر احتمالاتی برای دوره بازگشت ۴۷۵ ساله بدست آمد طیف طرح نیومارک را بدست می آوریم :

با داشتن نسبتهای ارائه شده بین PGA,PGV,PGD بصورت زیر عمل می نماییم:

$$V = c_1 \frac{a}{g} \qquad d = c_2 \frac{V^2}{a}$$

$$\begin{cases} c_1 = 48\ {}^{in}/_{sec^2} = 121.92\ {}^{Cm}/_{sec} \\ c_2 = 6 \end{cases}$$

(a = PGA , v = PGV , d=PGD)

$\Rightarrow$ a = 0.34 * 981 = 333.54 Cm/ sec 2

V= 121.92 * $\frac{333.54}{981}$ = 41.45 Cm/sec

d=6*$\frac{41.45^2}{333.54}$=30.91

- **ضرایب تشدید برای طیف (میا نگین + انحراف معیار) :**

β = 5%

$\alpha_a = 4.38 - 1.04 \ln(\beta) \Rightarrow \alpha_a = 2.706$

$\alpha_v = 3.38 - 0.67 \ln(\beta) \Rightarrow \alpha_v = 2.302$

$\alpha_d = 2.73 - ۰.45 \ln(\beta) \Rightarrow \alpha_d = 2.006$

- **ضرایب تشدید برای طیف (میا نگین):**

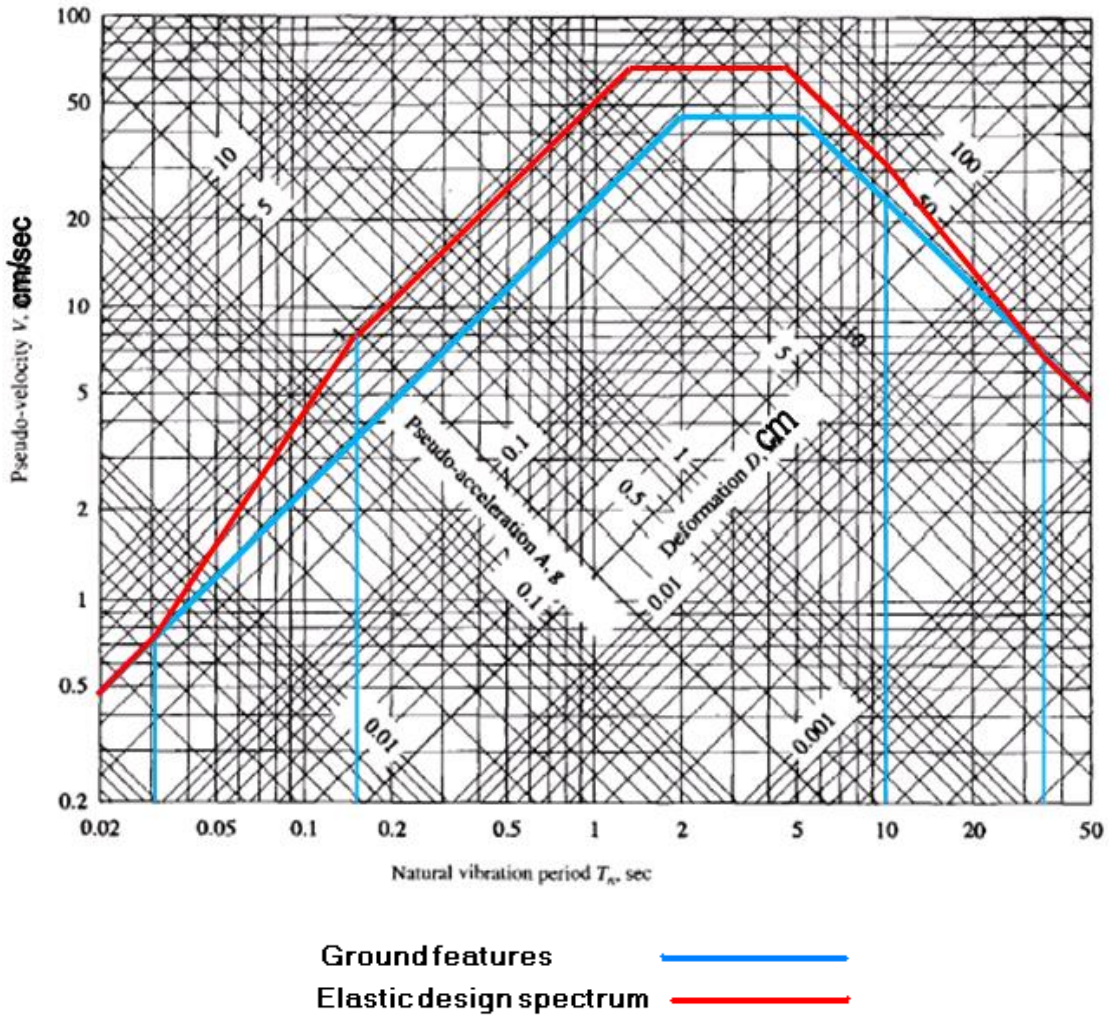
$$\begin{cases} \alpha_a = ۲,۱۲ \\ \alpha_v = ۱,۶۵ \\ \alpha_d = ۱,۵۹ \end{cases}$$

- مقادیر طیف الاستیک :

$S_{pa} = \alpha_a * \frac{a}{g} = 0.7208\ g = 707.1\ \ Cm/s^2$

$S_{pv} = \alpha_V * V = 68.39\ cm/s$

$S_d = \alpha_d d = 49.15\ cm$



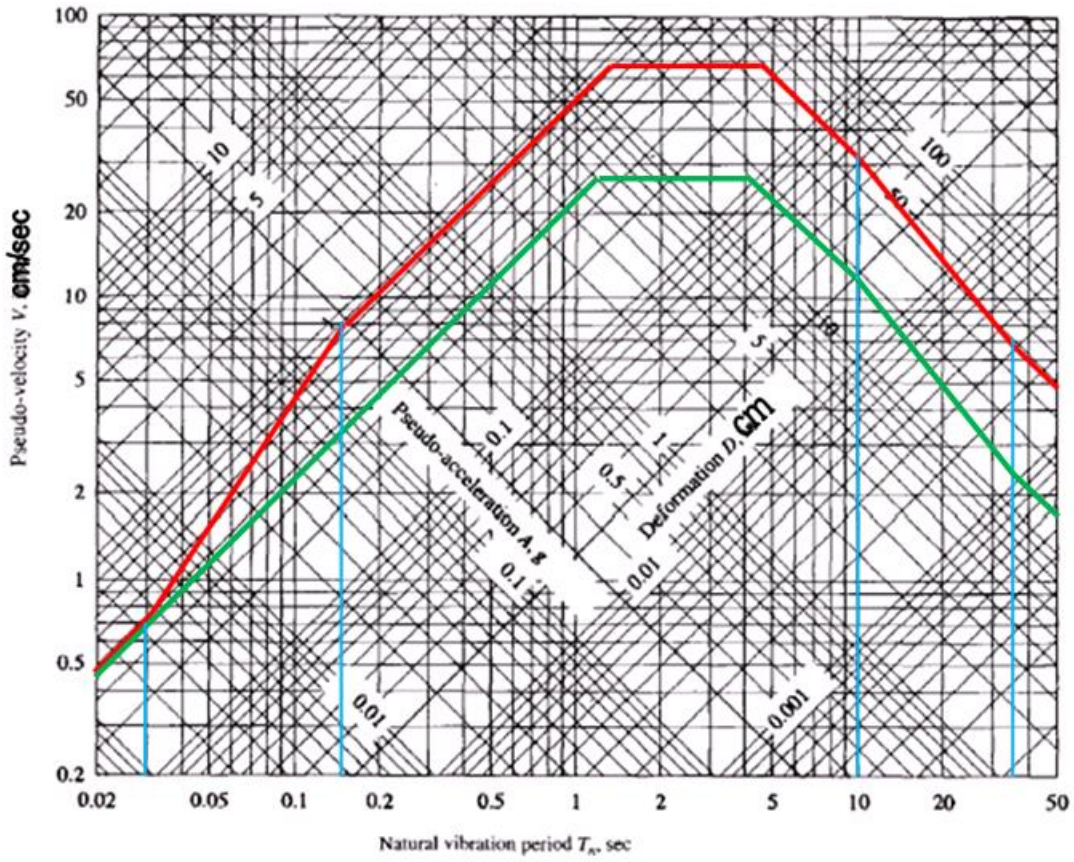
- طیف غیر الاستیک نیومارک :

ضریب شکل پذیری : $\mu = 2.$

V=68.39* μ^{-1} =27.36 cm/s

A=0.72g*$\frac{1}{\sqrt{2\mu-1}} = 0.36g$

D=49.15*μ^{-1}=19.66 cm



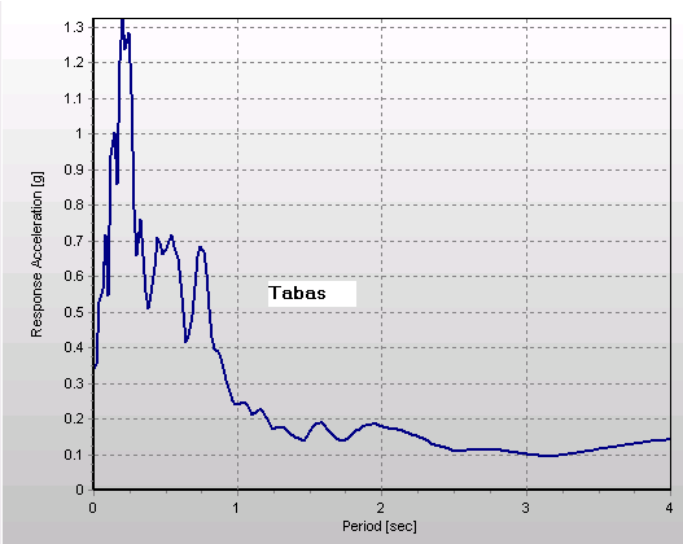
Elastic design spectrum

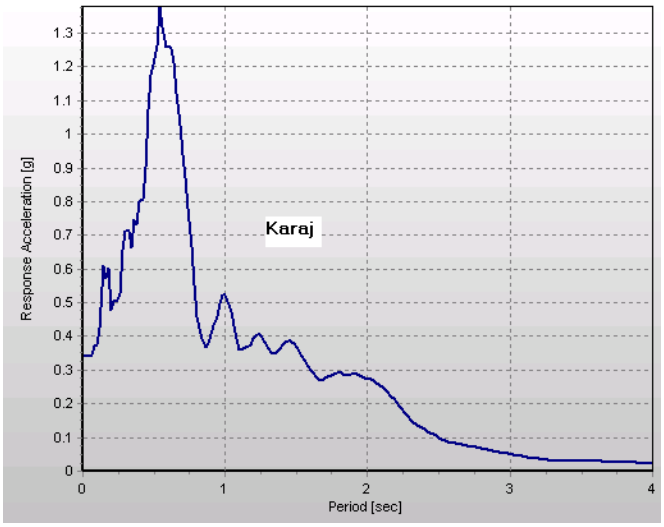
Inelastic design spectrum

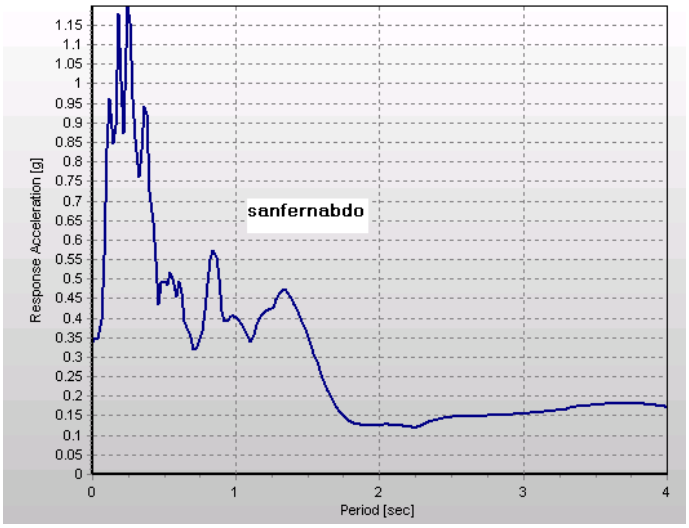
- طیف طرح از روی طیف پاسخ :

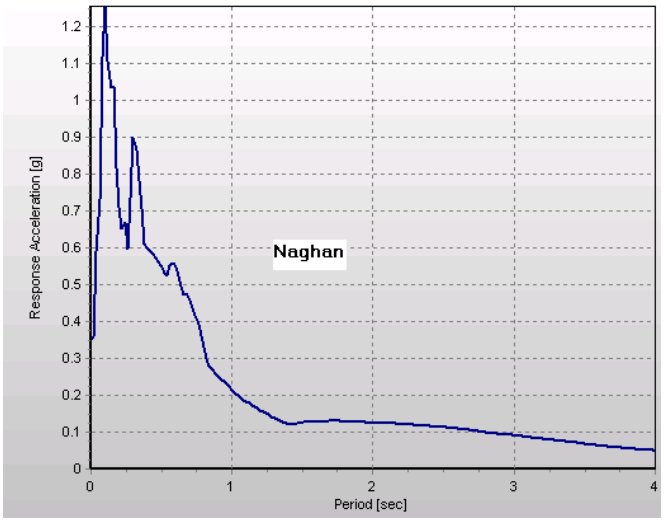
زلزله های انتخابی :

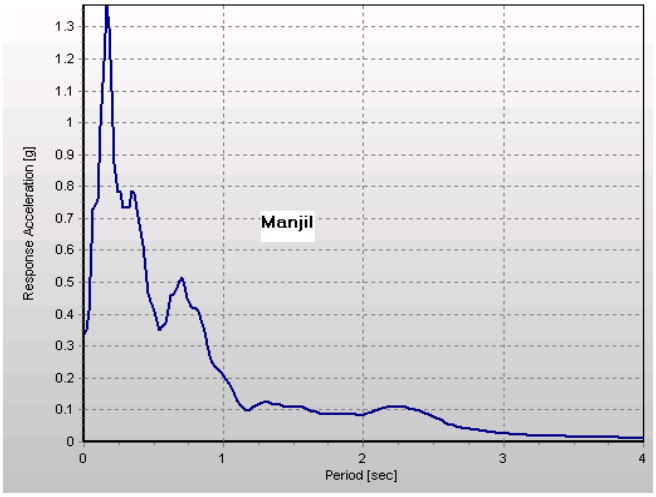
طبس ، منجیل ،کرج ، ناغان ، سن فرناندو , کرن

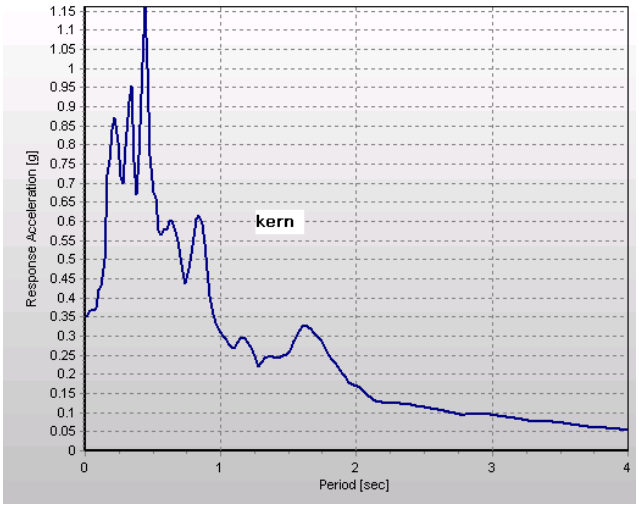




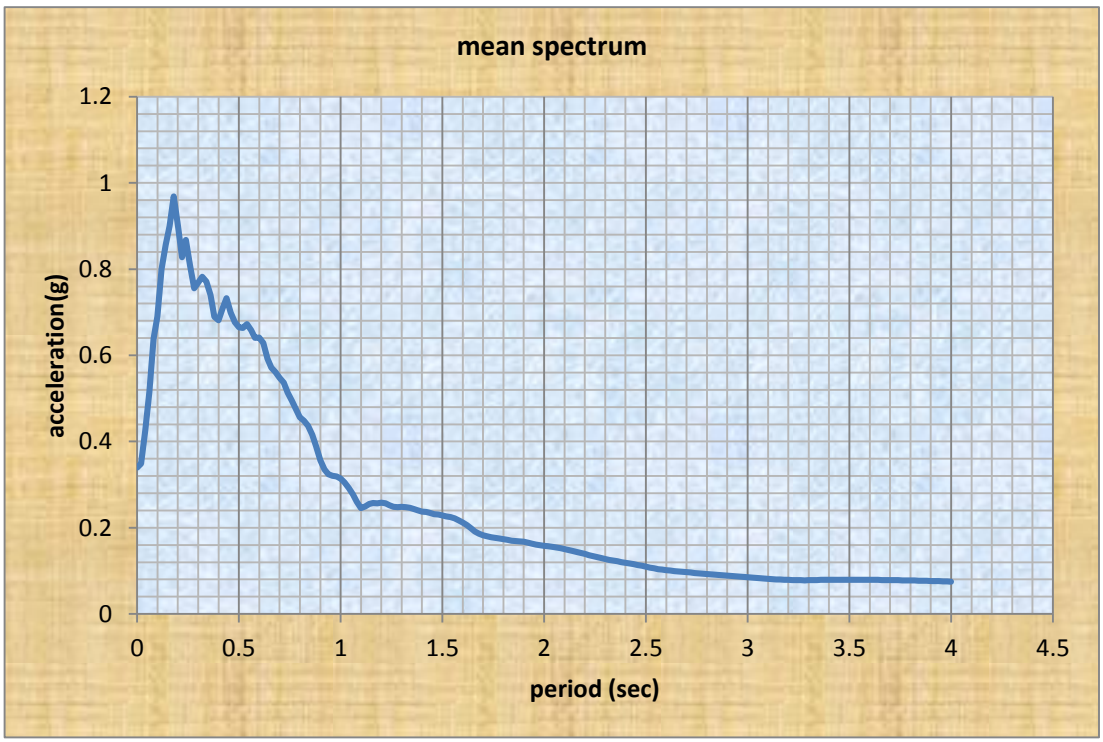




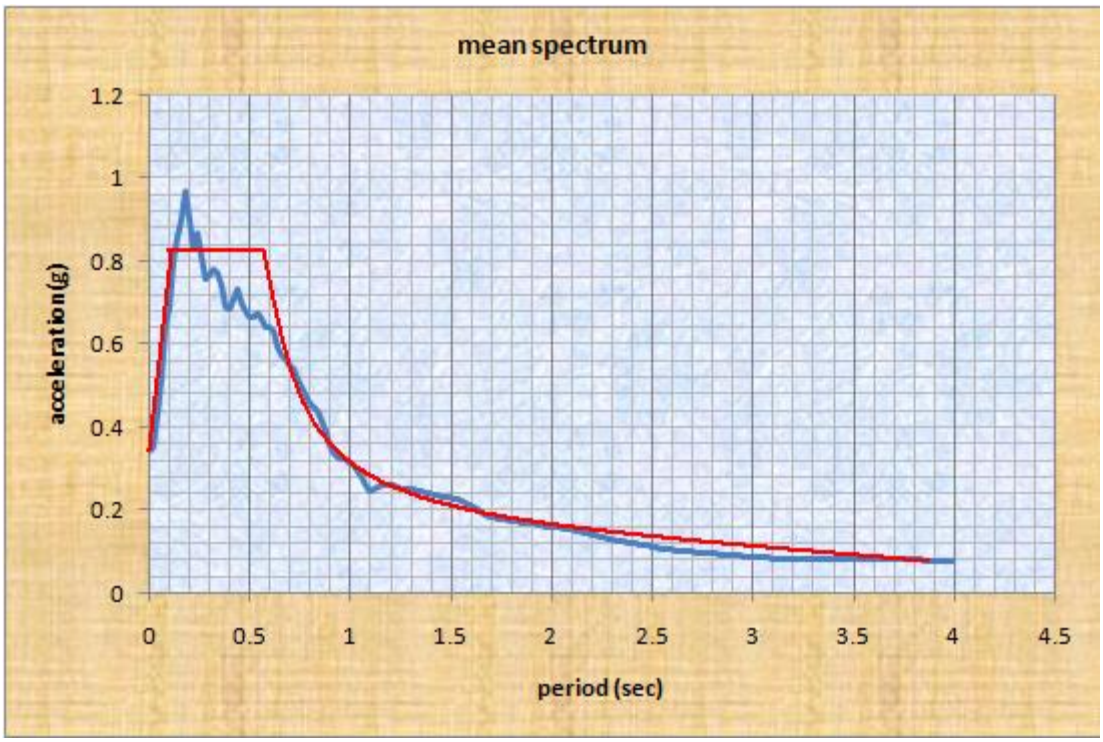

Manjil
Response Acceleration [g]
Period [sec]


kern
Response Acceleration [g]
Period [sec]

طیف میانگین:


mean spectrum
acceleration(g)
period (sec)

طیف میانگین صاف شده :



طیف uniform:

با استفاده از رابطه کاهندگی Boore, Joyner and Fumal و بکار گیری ضرایبی که در گزارش Green & Hall اشاره شده نمونه ای از طیف یکنواخت را برای R= 30و h=15 و M=6.9 بدست می آوریم:

$$\log(y) = b1 + b2^{*} M + b3^{*}(M-6)^2 + b4 * \sqrt{R^2+h^2} + b5 \log(\sqrt{R^2+h^2}) + b6^{*} G_B + b7^{*} G_c + \sigma_{\log y}$$

T=۰,۱ sec

b1=1.7 b2=0.321 b3=-0.104 b4=0.0 b5=-0.921 b6=0.039 b7=0.128

Gb=0.0 Gc=0.0 $\sigma_{\log y} = 0.194$ S_{pv} =**4.94**

T=۰,۱5 sec

b1=1.956 b2=0.323 b3=-0.117 b4=0.0 b5=-0.939 b6=0.137 b7=0.217

Gb=0.0 Gc=0.0 $\sigma_{\log y} = 0.194$ S_{pv} =**8.19**

T=۰,2 sec

b1=2.042 b2=0.332 b3=-0.112 b4=0.0 b5=-0.931 b6=0.185 b7=0.274

Gb=0.0 Gc=0.0 $\sigma_{\log y} = 0.196$ S_{pv} =**10.56**

T=۰,3 sec

b1=2.063 b2=0.354 b3=-0.092 b4=0.0 b5=-0.902 b6=0.231 b7=0.344

Gb=0.0 Gc=0.0 $\sigma_{\log y} = 0.204$ $S_{pv} = \mathbf{13.65}$

T=۰,4 sec

b1=2.029 b2=0.373 b3=-0.072 b4=0.0 b5=-0.876 b6=0.252 b7=0.388

Gb=0.0 Gc=0.0 $\sigma_{\log y} = 0.211$ $\boldsymbol{S_{pv} = 15.17}$

T=۰,7 sec

b1=1.917 b2=0.416 b3=-0.033 b4=0.0 b5=-0.833 b6=0.283 b7=0.459

Gb =0.0 Gc =0.0 $\sigma_{\log y} = 0.229$ $\boldsymbol{S_{pv} = 16.71}$

T=1 sec

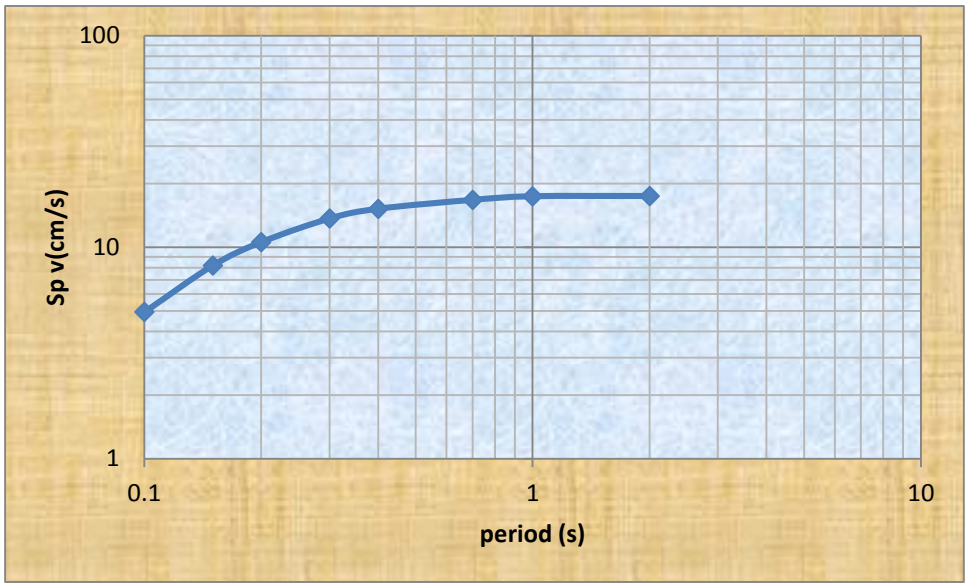
b1=1.858 b2=0.444 b3=-0.016 b4=0.0 b5=-0.825 b6=0.305 b7=0.497

Gb=0.0 Gc=0.0 $\sigma_{\log y} = 0.254$ $\boldsymbol{S_{pv} = 17.38}$

T=2 sec

b1=1.905 b2=0.491 b3=-0.028 b4=0.0 b5=-0.898 b6=0.381 b7=0.554

Gb=0.0 Gc=0.0 $\sigma_{\log y} = 0.287$ $\boldsymbol{S_{pv} = 17.43}$



- لازم به ذکر است که طیف فوق بر مبنای اطلاعات اندک و تعیین فاصله ، عمق و بزرگای مشخص رسم شد .