

The study of the cities of Iran in relation to seismology and distance to fault

*1-Jalal aldin shibani*2-Dr mehdi rezapor

¹Tehran university; jalalshibani 55@gmail.com ²Tehran university; rezapor.ut.ac.ir

ABSTRACT

The purpose of the investigation of seismic studies is to provide a more accurate picture of the characteristics of quaking and the potential seismicity of the intended region for the reasonable spending of the administrative costs of civil and industrial projects. The estimation of earthquake risk in seismicity regions has great importance for infrastructure facilities, because the inappropriate and unprofessional projects can result in many life and financial damages and losses. And also it causes to loss of manpower and waste of building materials. The safety factor should be determined by considering the useful life of the building and its importance in relation to the environment and the number of people who are in contact with it as well as the occurrence probability of earthquake in the location. This paper deals with the investigation of Iran's seismic situation and earthquake parameters measurement and as well as to review and study of the faults distance to Iran's major cities. In addition to the statistical analysis on the earthquakes which their magnitude was greater than 6/5 degree in terms of the Richter scale. Then, it was found that the destroyed towns distance to the earthquake epicenter was about 11 km.

Keywords: Earthquake, Risk analysis, seismicity regions and Iran

INTRODUCTION

In general, the accurate studies of seismology in theseismicity regions such as Iran in terms of preventing the material and spiritual assets waste, is a case that cannot be easily passed from it, so that during the past 90 years in worldwide, more than 2 million people and in Iran more than 235 thousand have lost their life for the earthquake occurrence. This figure compared to the total victims is equal to 6 percent given that Iran's population is equal to 1 percent of the world's population, so this the mortality rate indicates that the Iran country compared to the area and population is incurred the heavy losses.

From the years of 1920 to 1923, the mortality rate in Japan country was about one hundred thousand people which after the 40 years and by preparing and constructing the resistant buildings against of earthquake, the mortality rate was reduced to 26 people. Hence, the role of detailed studies for site selection and safety and urban, industrial and civil utilities is characterized against of earthquake.

One of the most seismically active regions in the world is the Alpine-Himalayan Belt which extends from the Azores to Indonesia. Anatolia locates in the most active section of this belt in the eastern Mediterranean and involves several important tectonic structures such as North Anatolian Fault Zone (NAFZ), East Anatolian Fault Zone (EAFZ), North East Anatolian Fault Zone (NEAFZ) and Bitlis Thrust Belt (BTB). Therefore Anatolia has been exposed to strong earthquakes along the history. Focal mechanisms of earthquakes in western Anatolia indicate that intra-plate deformations arising from vertical movements are occurring inside of the Aegean-Anatolian block. Most of the fault-plane solutions in western Anatolia represent normal faulting, indicative of crustal extension. Tensional axes for these solutions are nearly horizontal and perpendicular to the general east-west trend of graben structure. The Arabian plate moves northward, and forces the smaller Anatolian plate westward between the North and the East Anatolian Fault Zones as from Karlova triple junction. [1-3] showed that this motion is transferred into the Aegean in a southwesterly direction, resulting in the northern Aegean being dominated by dextral strike-slip faulting of northeasterly strike. The last earthquakes observed in China (Sichuan province, in May 12, 2008, $M_w = 7.9$), in Italy (Abruzzo region and the city of L'Aquila, in April 06, 2009, $M_w = 6.3$), on the island of Sumatra in Indonesia (in September 30, 2009, $M = 7.6$), in Haiti (Port-au-Prince, in January 12, 2010, $M_w = 7.0$), in Japan (Fukushima NPP area, in March 11, 2011) showed an insidious force of underground elements which brought destruction and suffering to these regions [4]. Iran is one of the earthquake-prone areas and high risk, which has been considered as an objective area in the current research. According to the following table, we have:

Table(1): The comparison of the mortality rate in Iran and compared to the global average

1920 to 2016	The total number of mortality on the earth	The number of mortality in Iran	Iran's area compared to the earth	The mortality percent
9 years	2/000/000 people	235/000 people	1%	6%

In the table (2), the initial information about the seismicity of different countries and the relevant regulations type are presented.

Table (2): The executive regulations of earthquake in different countries and Iran

No	Country Name	Publication Year	Type of Seismicity	Type of regulations in terms of safety
1	Albania	2008	Strong	Average
2	Argentina	2009	Strong	-
3	Afghanistan	-	Strong	-
4	Algeria	1955	Average	Average
5	Australia	2010	Weak	Average
6	Austria	2009	Weak	Average
7	Germany	2012	Weak	High
8	Indonesia	2003	Strong	Average
9	America	2014	Weak	High
10	Italy	2003	Weak	Average to high
11	Peru	1999	Strong	Average to high
12	China	2014	Strong	High
13	Turkey	2014	Strong	High
14	Chile	2001	Strong	High
15	Iraq	-	Strong	Low
16	France	2014	Average	High
17	Philippines	1982	Strong	Average to high
18	India	1998	Strong	High
19	Lebanon	-	Weak	-
20	Cuba	1994	Weak	Average
21	Japan	2015	Strong	Very high safety
22	Iran	1988	Strong	Weak to Average

As it is determined from the table (2), the European countries compared with Asian and African countries in terms of the implementation of safety regulations and retrofitting of buildings against of earthquake are placed in the higher rank.

The earthquake study in terms of probabilities:

In case of having the appropriate information such as the status of regional seismicity, statistical data and maps of seismicity can be performed the different statistical studies using standard methods over these data, for example, it can be determined the probable largest earthquake during the lifetime of a structure with the help of this obtained method. In case of the accurate and correct prediction of smaller earthquakes and considering this point that the earth grab is determinable for them, thus can be specified a reasonable instruction for earthquake loading. Then, the detailed studies on the distribution of the magnitude size of the earthquakes around the globe in specific areas such as the Alpine-Himalayan belt, Japan, California, the Mediterranean and Russia was conducted by different researchers that their best studies as Richter - Gutenberg empirical relationship was determined as the following form:

$$\log N = a - bM$$

N: Number of earthquakes
M: Magnitude

A: Specific constant value of each region

B: The ratio of large earthquakes to small earthquakes

In this paper, the values of a and b using the Seisan software with regard to the earthquake magnitude for different regions of the globe was obtained that these results are presented in the following table.

Table (3): The measurement the values of a and b by seisan software

Country	B	A
Japan	1.22	6.86
Canada West	1.09	5.05
America West	1.14	5.94
America East	1.38	5.79
Centra America	1.45	7.36
Peru	1.11	5.60
Chile North	0.88	4.78
Chile South	0.92	4.46
Mediterranean	1.10	5.45
Javeh	0.94	5.37
Africa East	0.87	3.80
Iran	1.18	6.02

With regard to the relationship between the magnitude and frequency, can be calculated the earthquakes occurrence probability time for a structure according to the values of a and b based on the following diagram

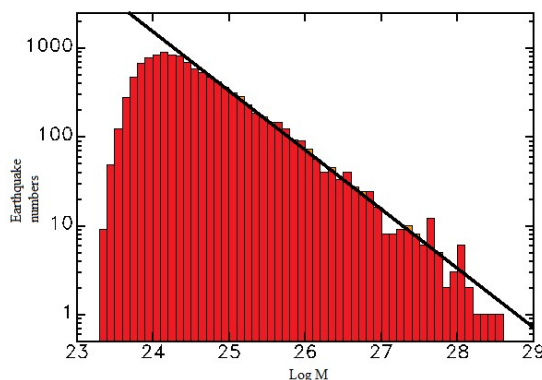


Figure (1): The Richter-Gutenberg relationship about the magnitude and frequency of earthquakes

The statistical status of Iran's earthquakes from the years 1959 to 2016:

From the years 1959 to 2016 AD, the number of 202 important earthquakes have been occurred in Iran which are as follow:

- 1) The number of 171 earthquakes with a magnitude of 5 to 6 degrees on the Richter scale;
- 2) The number of 23 earthquakes with a magnitude of 6 to 7 degrees on the Richter scale;
- 3) The number of 9 earthquake with a magnitude of 7 to 8 on the Richter scale.

The positioning status of Iran's cities against of the faults:

This paper deals with the statistical studies of Iran's cities and the large cities and overcrowded towards of these seismicity faults and in general, Iran's cities are divided into two categories [5, 6].

1) The cities which have placed on the fault or with the little distance of the faults;

2) The cities which have located on the two faults angle or on the internal bisector of the two faults.

Generally, the most of Iran's cities have located on the fault and the earthquake has happened in these cities and the places where are located of two faults confluence and have severely shaken, but it does not mean that if every city does not have a history of seismicity in where the big earthquake will not happen, for example, Tabas city with thousands-year history about three hundred years ago, only a microseism earthquake was experienced. But, however, in the year 1979 an earthquake with the magnitude of 7.7 degrees on the Richter scale was faced. As well as, the cities such as Shiraz, Sari, Qazvin and Babol have the great distances of the faults. But, however, the large earthquakes have occurred in the mentioned cities, because these cities are located on the internal bisector of the two faults.

Table (4): The Iran's cities distance to the earthquakes epicenter

No	City Name	The distance from the fault to KM	Fault length	Earthquake history	The occurred earthquake magnitude
1	Tabas	Near the fault		Has	7/5-7/8
2	Qir and Karzin	1	60	Has	7/1
3	Dorood	1	100	Has	7/4
4	Salmas	5	40	Has	7-7/5
5	Dasht Beyaz	6	120	Has	7-7/5
6	Buin Zahra	8	50	Has	7-7/5
7	Baghan	12	40	Has	7-7/5
8	Kohak	10	50	Has	7-7/5
9	Kerman	10	50	Has	7/1
10	Saravan	30	230	Has	7-7/5
11	Kermanshah	17	170	Has	7-7/5
12	Babol	35	300	Has	5-6
13	Sari	35	300	Has	6-6/5
14	Kazeroon	15	200	Has	5-6
15	Neyshabur	12	20	Has	5-6
16	Ardebil	20	65	Has	5-6
17	Urmia	20	65	Has	5-6
18	Esfahan	60	350	Has	5-6
19	Birjand	17	100	Has	6-7
20	Qom	10	50	Has	5-6
21	Mashhad	1	90	Has	5-6
22	Yazd	Along the fault	-	Has	4-5

The most of the Iran's cities mostly have built in the hillside of the mountains and according to the topography of Iran, the distance of mountain top and the cities centers, on average, are between 10 and 20 km, so according to pass of the many faults from the long distance of cities to earthquake centers will be about 15 to 20 km, for example, the statistical analysis on the earthquakes which their magnitude were greater than 5.6 on the Richter scale, which indicates that the destroyed cities distance to the earthquake epicenter was about 11 km.

As well as, according to the construction philosophy in the Iran's villages near of the aqueducts and the water outlet place from fountains which were located in near of the fault and fractures, so the Iran's urban and rural centers have located near of the fault or on the fault.

Table (4) dealt with the investigation and study of the Iran's cities and their distance to the near of the faults.

According to this table, it was determined that the most of Iran's big cities are located near the fault and this issue has the close relationship with the mortality rate and damages throughout the history.

Results:

1- With regard to the Iran's area compared to the Earth's surface area, the mortality rate and the earthquake damages in Iran is very high.

2- By measuring the ratio of large to small earthquakes in Iran, this amount is not the same in everywhere.

3- The European countries compared with Iran in terms of the implementation of safety regulations and retrofitting of buildings against of the earthquake are placed in the higher rank.

4- The most of the Iran's cities have built within the distances of 10 to 20 kilometers of the faults which this issue causes the mortality increase in Iran.

5- By having the values of a and b and the earthquakes gravity and frequency distribution of aftershocks, can be achieved the biggest probable earthquake in a region

In conclusion, the large earthquakes have occurred in Iran like its other regions and will occur in the future. For this reason, seismicity studies should be continued for minimizing the losses of life and property caused by earthquakes. Therefore, the tectonics features and active faults and activity of the region should be defined carefully and followed continuously.

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