SEISMIC CONDITIONS IN BAGHDAD REGION AND EVALUATION OF SEISMIC DESIGN FORCES

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ABSTRACT

In this paper, a study of the earthquakes that have affected Baghdad region in Iraq is made. The documents collected from different references are analyzed to determine the seismic zone of Baghdad. Evaluation of seismic design forces for equivalent static analysis of earthquakes in Baghdad region is made according to the Iraqi seismic code and the International Building Code (IBC, 2000).

The studies reached that intensity greater than V on Mercalli Scale has never been recorded on the site at Baghdad. While Seismicity Map of Iraq, proposed by Iraqi Seismic Code, reveals that, Baghdad places in a zone of intensity between (VI-VII) on the Modified Mercalli Scale. Also, the studies reached that magnitude greater than 5.7 on Richter Scale has never been recorded on Baghdad.

When calculating the total horizontal seismic design force acting on buildings and structures according to the formula of the Iraqi Seismic Code Requirements for Buildings (1997), the coefficient Z (seismic hazard zoning coefficient) shall be taken as (0.05) for Baghdad region.

الخلاصة

في هذا البحث اجريت دراسة عن الهزات الارضية التي اثرت على منطقة اربيل في العراق. ان المعلومات التي جمعت من عدة مصادر تم تحليلها لتحديد المنطقة الزلزالية لأربيل. وتم تحليل وتقويم القوى الزلزالية التصميمية المكافئة للقوى الساكنة في منطقة اربيل بناءا على متطلبات المدونة الزلزالية العراقية ومدونة البناء العالمية (IBC, 2000).

لقد اظهرت الدراسات ان شدة زلزالية اكبر من (5) حسب مقياس ميركالي لم تسجل في موقع اربيل خلال الفترات السابقة، بينما نصت المدونة الزلزالية العراقية وبناءا على الخارطة الزلزالية للعراق ان تقع ضمن شدة زلزالية اكبر من (7) حسب مقياس ميركالي المعدل. وعند حساب القوى الزلزالية الجانبية التصميمية المؤثرة على الابنية والمنشأت بناءا على المدونة الزلزالية العراقية يتبين ان المعامل Z (معامل المنطقة الزلزالية) يجب ان يؤخذ (0.05) لمنطقة بغداد

KEY WORDS
Baghdad, earthquake, magnitude, intensity, seismic force.

INTRODUCTION

When the ground is shaken by an earthquake, affected buildings must respond to the adjacent ground motion. Damage produced by earthquakes has provided some insight into how buildings respond. This information has been greatly augmented in recent years by theoretical and experimental studies of the response of structures to random vibratory loadings similar to those produced by earthquakes.

The vibratory ground motion to which a structure or building responds can be considered from two different aspects: the general geographic region in which the building is located; and the close-environmental, where the building can be influenced by local conditions (Perry and Rutledge, 1974).

RISK EVALUATION

Seismic risk should be expressed in terms of return periods, such as done for winds and floods. The basic seismological information obtained from the seismic geology and the available seismic record should be converted into terms suitable for use by the engineer. Magnitude information, or even Modified Mercalli intensity values, can be expressed as return periods or probability curves rather than as ill- defined terms such as "probable maximum" or "lifetime earthquake". For a well-balanced economic design, it is necessary to know how quickly the risk of occurrence decreases as the intensity of ground motion increases. It has been found empirically by several investigators (Nordguist, 1945; Milne and Davenport, 1965; Disk, 1965) that the distribution of maximum magnitude or intensity in a region can be represented by an extreme value distribution of the Gumbel (1958) type.

The sources available from which a seismic hazard assessment for central Baghdad can be made are as follows:

1- The study of tectonic structure and regional geology.
2- Historical records of seismic events.
3- Recent (post 1900) quantitative records of earthquakes in the surrounding region (Khulafa Street Project, 1981).

DISTRIBUTION OF EARTHQUAKES IN IRAQ

The North, North- East, and East of Tigris regions suffered from the strongest earthquakes. The scale of these quakes became lower and weaker as they move towards the South and South- West regions of Iraq. When the earthquakes distribution map is drawm according to the lines of expected highest intensities of the earthquaks, it was found that the scale ranges between (5) and (9) according to the Modified Mercalli Scale (Al Omari, et al., 1982). **Fig. (1)** shows a map of the regions for the earthquake focuses within the geographical boundaries of Iraq (longitude 38- 50 °N) and (latitude 28- 38 °N), which are derived from the earthquakes and tectonics information available at the Earthquakes Monitoring Center- Iraqi Scientific Research Council for the period between (1900- 1999) (Earthquakes Monitoring Center- Iraqi Scientific Research Council). **Fig. (2)** shows the regions of high intensity earthquakes (according to Modified Mercalli Scale) in Iraq (Fahmi, 1984).

HISTORICAL RECORDS OF SEISMIC EVENTS

Iraq possesses a well-documented history of seismic activity and Al-Sinawi and Ghalib (1975) have prepared a comprehensive catalogue of historical earthquakes covering the period 1260 B.C. to 1873 A.D. Ambraseys (1978) provides a valuable reassessment of the seismicity of the Middle East from which it is possible to obtain a reasonable prediction of the earthquake related ground motions in this area.

STUDIES OF EARTHQUAKES

Magnitude

United Kingdom Institute of Geological Sciences Global Seismology Unit (I.G.S)

This analysis was based on the computer listing and map provided by the United Kingdam Institute of Geological Sciences Global Seismology Unit. This listing contains all the earthquakes found in the file within a 10° region of latitude and longitude approximately centered on Baghdad. These events were recorded between (1905-1978) (I.G.S, 1981). These data can be seen in **Fig. (3)** and these events have been plotted on map, which is reproduced in **Fig. (4)** (Khulafa Street Project, 1981).

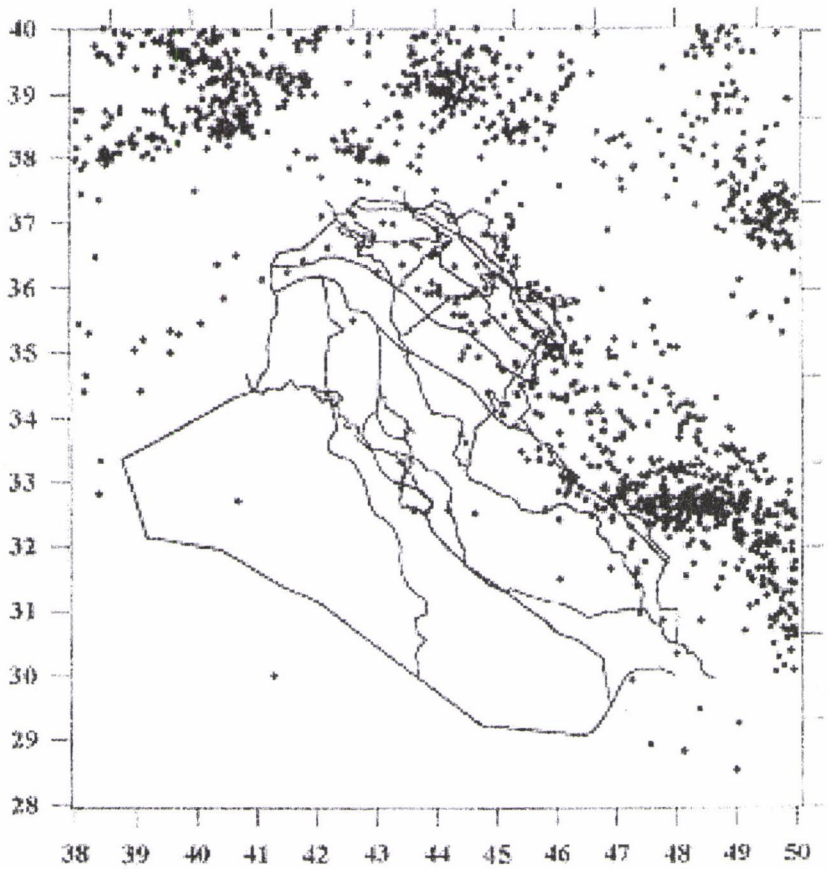


Fig. (1) Map of the regions for the earthquake focuses within the geographical boundaries of Iraq (1900- 1999) (from Earthquakes Monitoring Center- Iraqi Scientific Research Council).

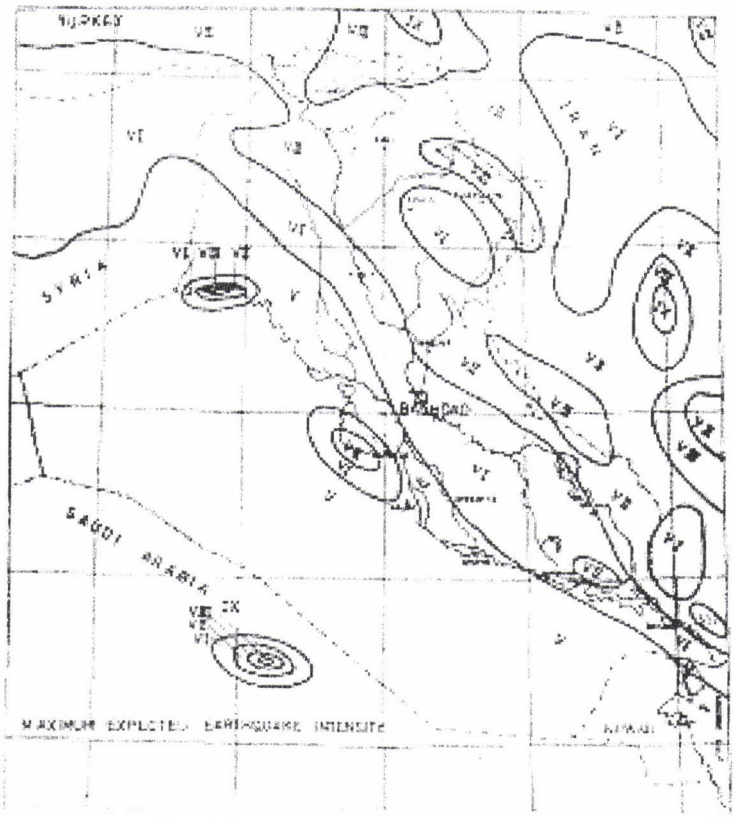


Fig.(2) The regions of high intensity earthquakes in Iraq (from Fahmi, 1984).

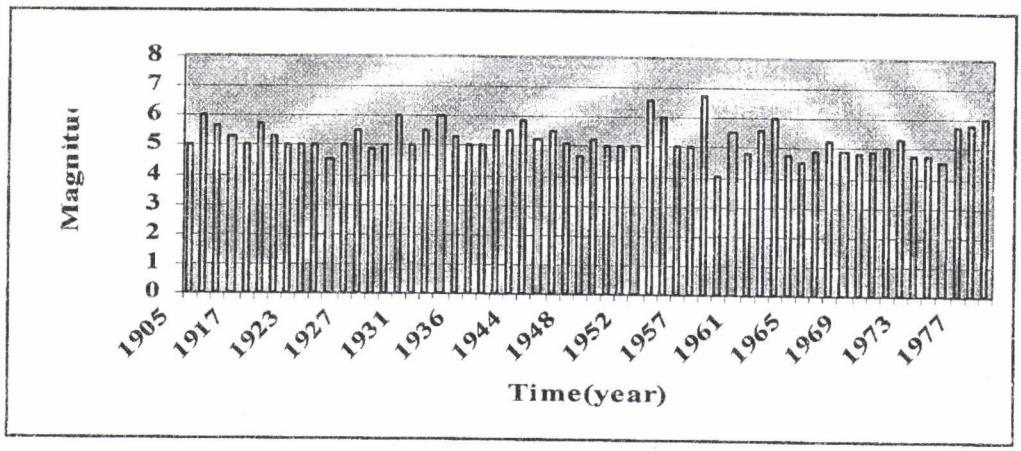


Fig. (3) Earthquakes records found within 10° region of latitude and longitude approximately centered on Baghdad (1905-1978).

From **Fig. (3)**, it can be seen that the magnitude reached a maximum value of about 6.6 on Richter Scale. From **Fig. (4)**, It can be seen that the majority of the events recorded have their origins in a band running NW- SE some 150 to 350 km from Baghdad at its nearest, which corresponds to the suture zone between the Arabian and Iranian tectonic plates see **Fig. (5).**

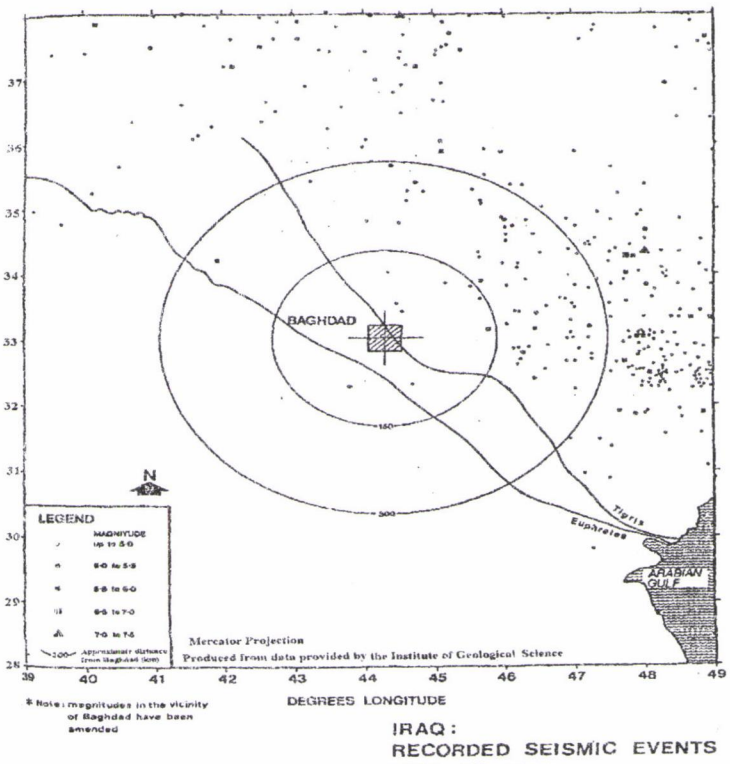


Fig. (4) Recorded seismic events (1905-1978).

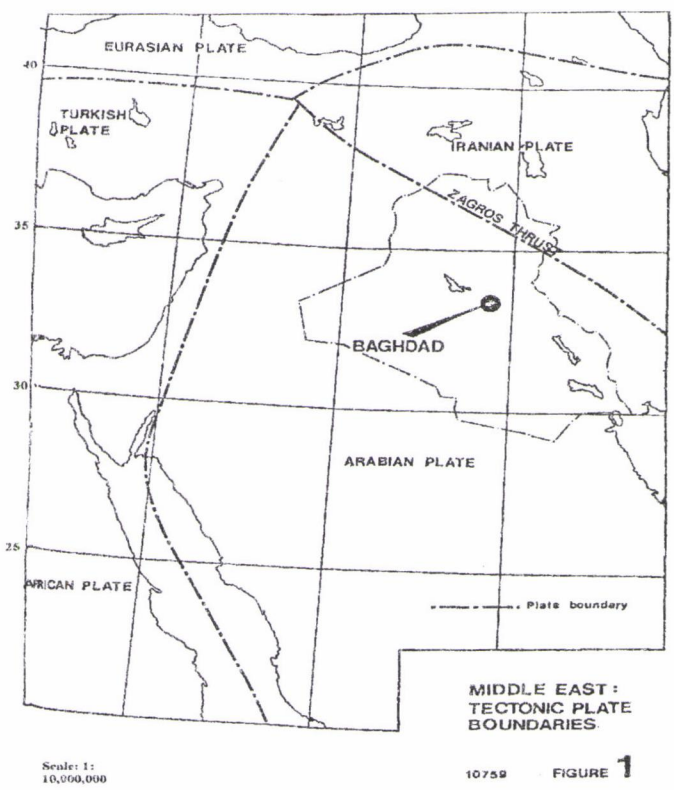


Fig. (5) Middle East Tectonic plate boundaries.

To ensure the validity of the records, which are of particular significance to the analysis, details of events within a radius of approximately 150 km of Baghdad were individually verified or, if necessary, amended by Professor N. N. Ambraseys of Imperical College. **Table (1)** and **Fig. (6)** present the results of this comparison.

From **Table (1)** and **Fig. (6)**, it can be shown that the earthquakes may occur at random locations within the plate with magnitude up to 5.7 on Richter Scale.

INTENSITIES

Many studies are made to draw intensity contours. These contours show intensities that Iraq is subjected to four different periods (return periods of 50, 100 and 200 years and projected life time of 50, 100 and 200 years). This can be shown in Figs. 7, 8, 9, 10, 11 and 12 (Puttonen and Varpasuo, 1982). Seismicity map of Iraq recoded by Iraqi Seismic Code Requirements for Buildings (1997) shows that Baghdad is subjected to intensity between VI-VII on Modified Mercalli Scale see **Fig. (12)**

Table (1) Verification of I.G.S. epicenters in the vicinity of Baghdad, (from Khulafa Street Project, 1981).

Year	Latitude	Longitude	Magnitude
1917	30.37N	46.86E	5.0
1917	33.48N	45.82	5.6
1918	34.50N	41.80E	5.7
1918	34.50N	41.80E	5.7
1919	34.50N	41.80E	5.3
1919	34.50N	41.80E	5.2
1920	33.50N	46.50E	5.0
1920	33.15N	46.14E	5.4
1930	32.50N	43.70E	5.3
1930	32.50N	43.70E	5.3
1932	33.00N	47.00E	5.5
1932	32.52N	47.38E	5.0
1940	33.50N	46.50E	5.5
1940	33.44N	46.71E	5.4
1950	34.00N	45.50E	5.0
1950	33.58N	45.50E	4.8
1956	33.10N	46.60E	5.0
1956	33.31N	46.72E	5.2
1962	33.40N	46.00E	4.0
1962	33.44N	46.11E	4.1
1967	33.75N	44.43E	3.9
1967	33.60N	44.40E	3.8
1972	32.87N	46.83E	5.3
1972	32.88N	46.85	4.4
1975	32.50N	44.65E	3.0
1975	32.50N	44.70E	3.7
1976	33.62N	44.50E	3.0
1976	33.62N	44.50E	3.5

Note: For each event the upper line is the I. G. S. record, the lower is the amended record.

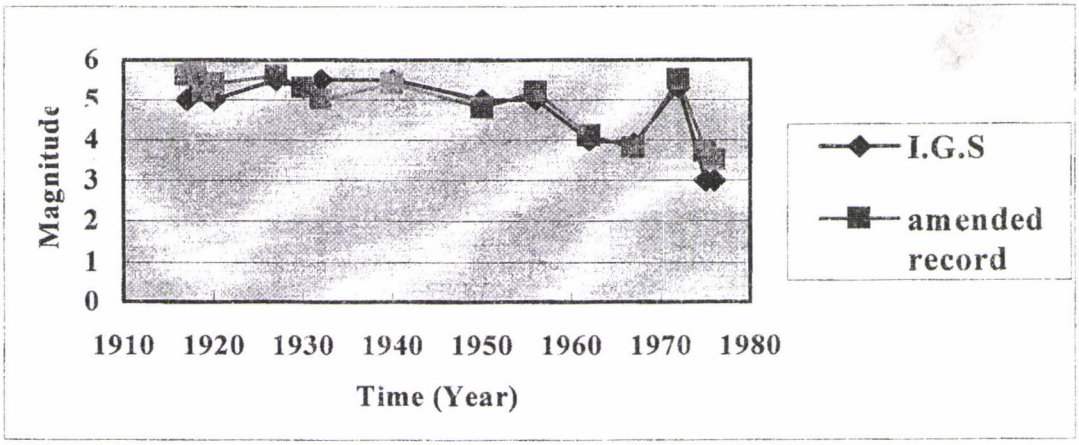


Fig. (6) Verification of I.G.S epicenters in the vicinity of Baghdad, (data from Khulafa Street Project, 1981).

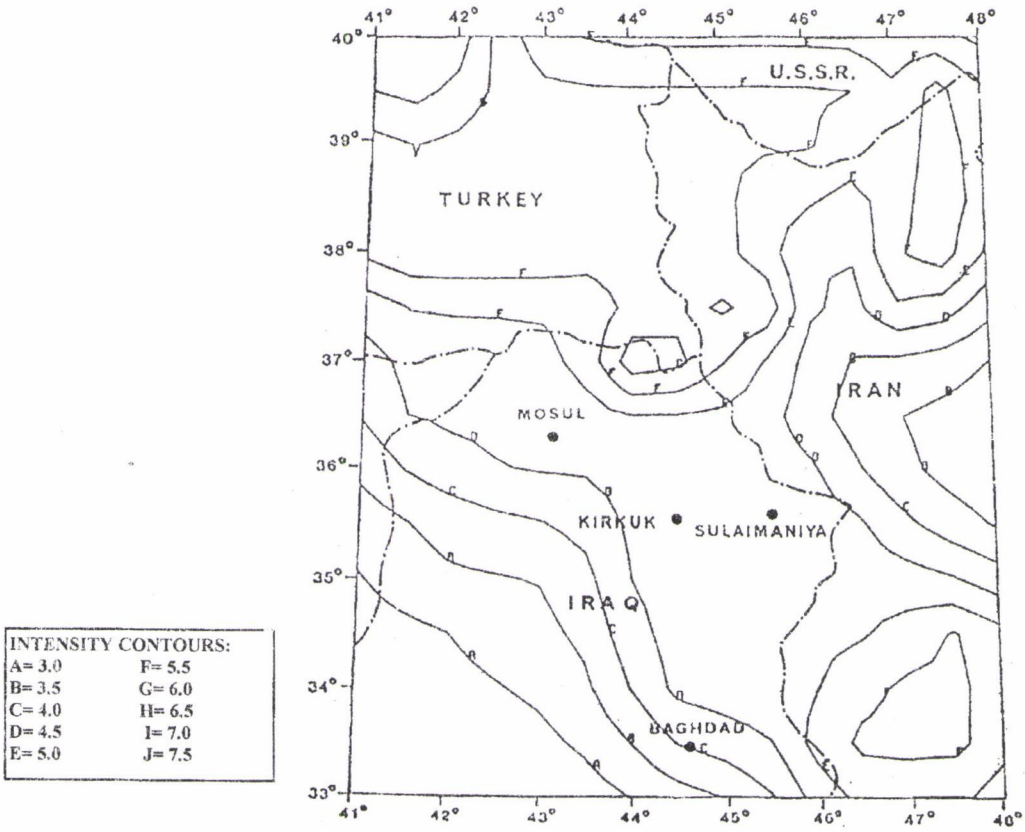
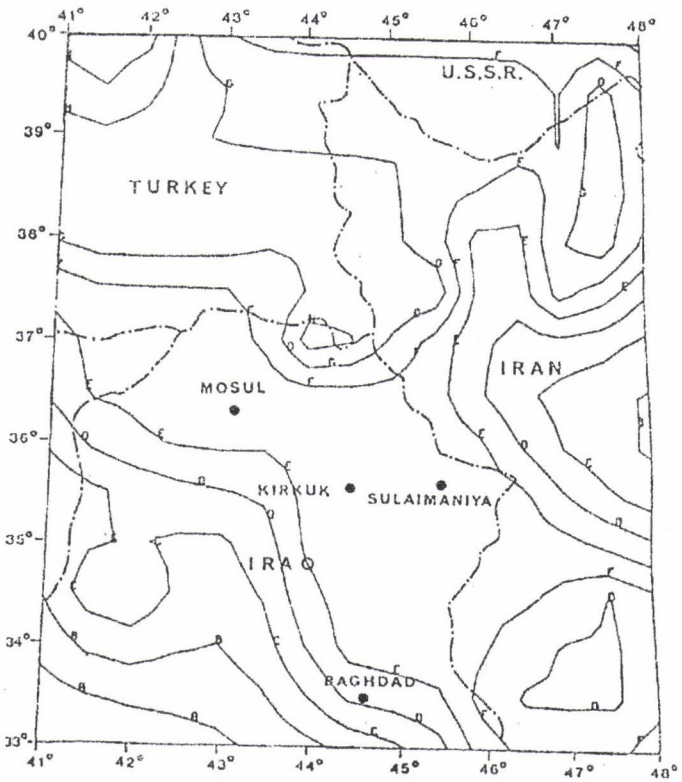
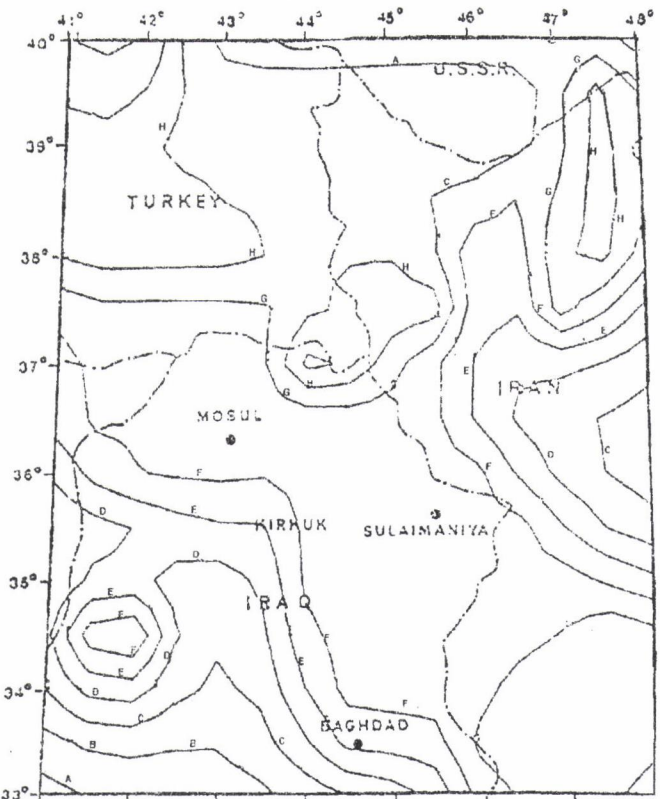


Fig. (7) Intensity contours: return period of 50 years (from Puttonen and Varpasuo, 1982) .



INTENSITY CONTOURS:	
A= 3.0	F= 5.5
B= 3.5	G= 6.0
C= 4.0	H= 6.5
D= 4.5	I= 7.0
E= 5.0	J= 7.5

Fig. (8) Intensity contours: return period of 100 years (from Puttonen and Varpasuo, 1982).



INTENSITY CONTOURS:	
A= 3.0	F= 5.5
B= 3.5	G= 6.0
C= 4.0	H= 6.5
D= 4.5	I= 7.0
E= 5.0	J= 7.5

Fig. (9) Intensity contours: return period of 200 years (from Puttonen and Varpasuo, 1982).

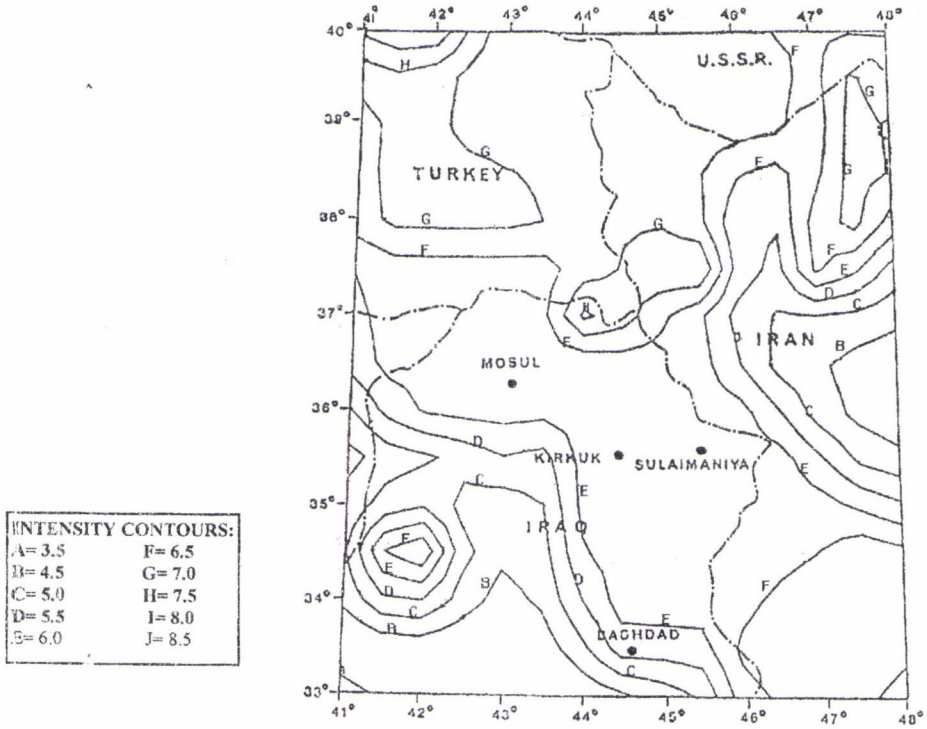


Fig. (10) Intensity contours: projected lifetime of 50 years with an exceeding probability of 10 percent (from Puttonen and Varpasuo, 1982) .

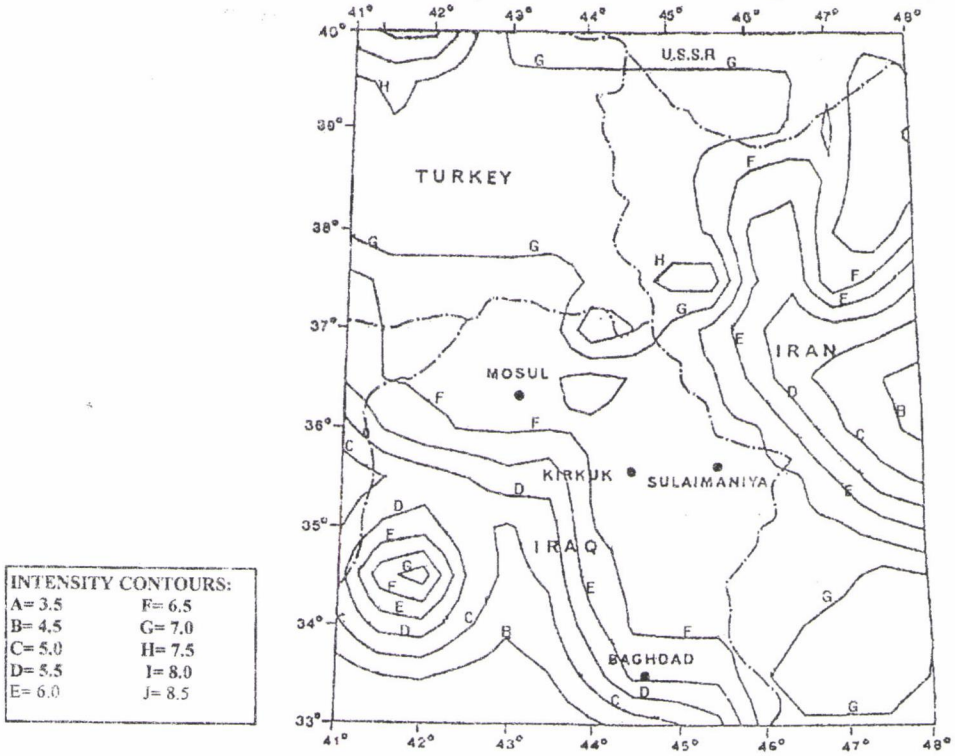


Fig. (11) Intensity contours: projected lifetime of 100 years with an exceeding probability of 10 percent (from Puttonen and Varpasuo, 1982) .