

SOURCE PARAMETERS OF THE 26 APRIL 2007 BAM EARTHQUAKE OBTAINED BY THE NEAR FIELD ACCELEROGRAMS DATA

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ABSTRACT After 26 December 2003 hundreds of aftershocks have occurred in Bam. There are 27 recorded earthquakes with the magnitude with $5.1 > M > 3.8$ obtained from USGS. The last event with $M = 4.9$ (NEIC) was on 26 April 2007. In this study, we calculated the ground motion parameters of the last event using digital accelerograms Data of Building and Housing Research Center (BHRC) by using Seismosignal and Sac softwares.

These parameters listed in Table 2. We determined the location of the epicenter, our motivation of these computations was the determination deference of epicentral location with Minimum and Maximum 20, 50 km respectively. The occurrence of strong earthquake such as the 26 April 2007 indicates the Bam region is still seismically active.

INTRODUCTION

On 26 December 2003 at 05:26LT (01:26GMT), a catastrophic Earthquake Mw 6.6, seismic moment ($6 - 9 \times 10^{18}$ N m) struck the city of Bam in the Kerman province of southeast Iran (figure1). The intense shaking in the city caused the complete collapse of nearly every building in the central parts of the city including many of the newer buildings, killing about 40000 people officially. The city lies to the east of the Nyband - Gowk - Sarvestan fault system and on which several large earthquake have occurred over the past 23 years [Berberian et al., 1984; Berberian and Qorashi, 1994; Berberian et al., 2001]. There are no recorded historical earthquakes at Bam. Most of the citadel of Arg-e-Bam, one of world heritage sites inscribed by UNESCO, which was constructed by mud brick about 2000 years ago destroyed in this earthquake.

Four large earthquakes ($M > 6$) since 1981 have occurred near the Gowk fault zone [Berberian et al., 1984, 2001]. The Gowk fault zone, a predominantly right-lateral strike-slip zone that extend from 50 km west of Bam northward [Walker and Jackson, 2002], has also been associated with several large historical earthquakes [Ambraseys and Melville, 1982; Berberian and Yeats, 1999].

After the mainshock, hundreds of aftershocks including 27 events larger than 3.8 (USGS) have occurred in this region. In this study, we calculated the location of the epicenter and other parameters of the last event (with Mw 5) using digital accelograms Data of Building and Housing Research Center (BHRC). We obtained the seismic moment as $M_0 = 3.6 \times 10^{23}$ Dyne- cm, and the moment magnitude as $M_w = 5$. The results of this study are in agreement with the other computation results.



Figure-1. Bam in southeast Iran

DATA ANALYSIES

There are 6 accelerogram stations in and around the city of Bam which were installed by BHRC. Using the Seismosignal and SAC softwares, we plotted all of the three components of the accelerograms, and then we measured t_s - t_p , Epicentral distance (R) and PGA for each record. These parameters were listed in Table1. After baseline correction and filtering of the accelerograms, we plotted Fourier Spectrum of accelerations. By using these plots we obtained corner frequency (f_c) and flat portion spectrum (K) of the Fourier Spectrum. Reading of dash line quantities (Table1) was difficult. We showed an example of accelerogram in figure 3 and two examples of Fourier Spectrum in figures 2 and 4. We used the acceleration spectrum of S-wave, recorded on horizontal components in SAC software.

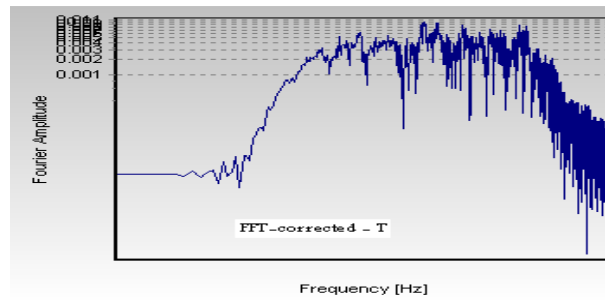
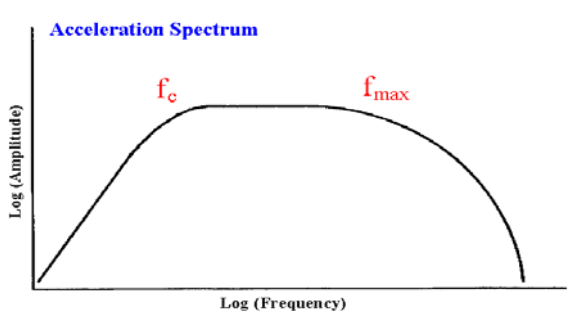


Fig2. Fourier spectrum of Bam station.

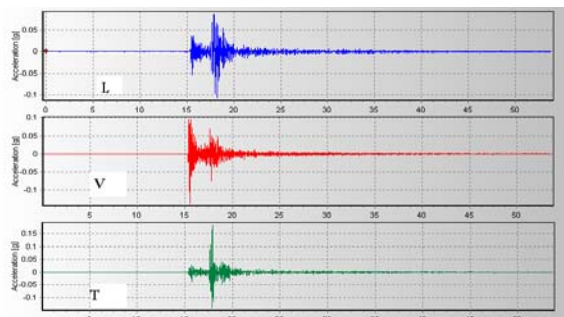


Fig3. Three components of Baravat accelerogram station.

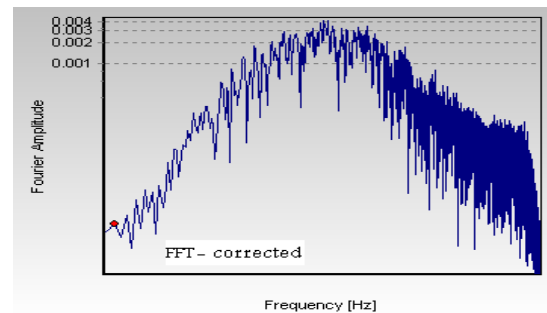


Fig2. Fourier spectrum of Abareq station

To estimate M_0 from acceleration spectrum, first we must estimate K , then we compute Ω_0 from $\Omega_0(2\pi f)^2 = K$. Finally, we could reach to M_0 by equation 1 [J. Shoja-Taheri, S. Naserieh, and A.H. Ghafoorian-Nasab 2005]. Each parameter must be in SI unit which lead to M_0 in N.m, but to determine M_w in equation 2, M_0 in dyn.cm is required. M_0 (dyn.cm) = M_0 (N.m). $1e+007$

$$M_0 = \frac{4\pi\rho\beta^3}{\mathfrak{R}_{\theta\phi}FVG(R)}\Omega_0(1) \quad M_w = 0.667M_0 - 10.7 \quad (2) \quad [\text{Lay, T. and T.C. Wallace, (1995)}]$$

Ω_0 (m.sec) Long period part of spectrum(before f_c);

$F = 2$ Free surface amplification;

$V = 1/\sqrt{2}$ a factor for correction of energy partitioning on two horizontal components;

$\rho = 2700 \text{ kg/m}^3$ Density;

$\beta = 3000 \text{ m/s}$ S- wave velocity;

$\mathfrak{R}_{\theta\phi} = 0.55$ Radiation pattern;

$G(R)$ (m) Geometrical spreading correction ;

$$G(R) = \begin{cases} R^{-1} & , \quad R \leq 100Km \\ (100 \times R)^{-\frac{1}{2}} & , \quad R > 100Km \end{cases}$$

R (m) Epicentral distance; all of the distances in this study are less of 100 km so we used from $G(R) = R^{-1}$.

We calculated Average of corner frequency (f_c) of three components and flat portion spectrum (K), then substituted them in equation 1.

We obtained M_0 and M_w for each station (Table1), then we Averaged these quantities and obtained $M_0 = 3.6 \times 10^{23}$, and $M_w = 5$; the results are consistent with the computation results.

Table-1. Ground motion parameters of 26 April 2007 Bam earthquake

Station	st. coordinates		P.G.A (g)			Corner freq(Hz)			k	ts-tp (s)	R(km)	Mo(dyn.cm)	Mw
	Lat	Long	L	V	T	L	V	T					
BAM	29.079	58.353	0.068	0.062	0.061	3.25	3.10	1.45	0.5	2.15	17.2	3.88X10 ²³	5.03
QOTB ABAD	28.883	58.483	0.042	0.013	0.034	-	1.96	-	0.1	5.06	40.48	3.27X10 ²³	4.98
BARAVAT	29.01	58.402	0.0101	0.138	0.185	-	3.125	2.9	0.7	2.27	18.16	4.66X10 ²³	5.08
ABAREQ	29.347	57.94	0.027	0.018	0.035	5.1	-	-	0.3	7.3	58.4	2.088X10 ²³	4.85
M.A.MASKUN	28.908	57.888	0.019	0.0068	0.0075	1.62	1.66	1.7	0.1	7	56	6.299X10 ²³	5.17
POSHT- RuD	29.123	58.381	0.0773	0.0776	0.0693	4	-	3.6	0.7	1.7	13.6	14.16X10 ²³	4.87

THE EPICENTRAL LOCATION

We obtained ts-tp from accelerographs using six accelerogram stations and determined epicentral distance(R) using $R \text{ (km)} = 8(t_s - t_p)$ (Table1). We converted coordinates of stations to metric (UTM); then, we plotted 6 circles with radius = R, and centers equal to stations coordinates; finally, we determined the fittest confluence point in confluence surface. We converted the obtained point coordinate to degree again. We selected a map of region from Google earth correctly and add to ArcGIS software. We plotted this location and the other locations on map; Figure 3 shows these locations on region map. The other seismological Agencies are: Institute of geophysics Tehran University (IGTU), International Institute of Earthquake Engineering and seismology (IIEES) and National Earthquake Information Center (NEIC). Table2 shows the magnitude and epicenter located by different organizations. Geology and Tectonic studies and the field observations show that the IGTU and NEIC have less accuracy; only few walls of gardens collapsed in villages northeast of Bam. The closest seismograph station of IGTU is about 500 km far from Bam and NEIC does not have any station in Iran; the closest station of IIEES has 200 km distance, but the distances of accelerogram station are 13 to 59 Km. These results imply that the location of this study is reliable and has more accuracy.

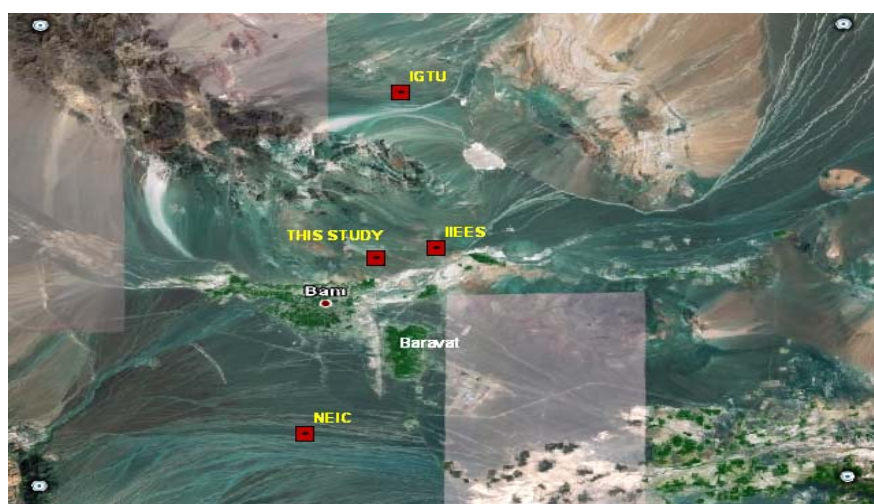


Figure-3. The location of 3/26/ 2007 Bam earthquake by: NEIC, IGTU, IIEES and this study.

DISSCOSSION AND COCLUSION

Table-2. The magnitude and epicentral location

Agency name	Magnitude	Long	Lat
NEIC	4.9	58.34	28.98
IIEES	5	58.45	29.17
IGTU	5.1	58.42	29.33
this study	5	58.4	29.16

We calculated seismic moment (M_0) and moment magnitude (M_w) to be 3.6×10^{16} N.m and 5 respectively and the other ground motion parameters that are listed in Table1, by using digital accelerograms Data of Building and Housing Research Center (BHRC), using the Seismosignal and Sac softwares. We located the epicenter by using recorded digital accelerograms. The epicentral location obtained in this study is consistent with the field observations and the geological evidences. The occurrence of strong earthquake such as the 26 April 2007 indicates the Bam region is still seismically active, and the occurrence of other destructive earthquakes around the epicentral area of the 2003 Bam earthquake in future is not out of expectation.

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