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The Bam Earthquake Analysis and its Geomorphological Manifestations and Evidences

H. Negaresh and M. Khosravi
Geography Department, University of Sistan & Baluchestan

Abstract:

Bam is a historical city located like a pearl in the heart of Lut Desert and on the Kerman-Zahedan highway. By virtue of the primeval mud-constructed citadel (Arg e Bam which was founded about 2000 years ago), the city has acquired a world-wide name and fame. Unfortunately, a harrowing and horrendous earthquake measuring 6.5 on the Richter scale jolted the city early on a Friday morning exactly at 5:26:26 AM; December 26, 2003 .The city was razed to the ground inflicting heavy losses of life and property. More than 110,000 inhabitants lived in Bam before December 26, 2003 earthquake. More than 35,000 people were killed, about fifty thousand were injured and many people were rendered homeless by the vicious earthquake that shook the ground on the 26th of December, 2003.

Though several papers have been written on the Bam earthquake tragedy, this paper initially endeavors to tackle the analysis of the Bam earthquake phenomenon and discuss the natural and general causes and grounds prompting such a high death toll and an extensive loss of property; and then take into account the geomorphological evidences and manifestations resulting from the aforementioned calamity.

Key Words: Earthquake, fault, fault activity, seismic zone, Seismic city, epicenter, superficial earthquake, making buildings resistant, precipitation, landslide subsidence.

1- Statement of Problem:

The destructive and catastrophic earthquakes in the recent decades have proved that Iran is prone to having frequent seisms since it is located on seismic belt of the globe and hence has perpetually been tormented by such tribulations and cataclysms; thus no corner of the land stands safe from earthshaking. Sadly to say that while some of the Iranian cities such as Bam are lying on the periphery of faults whose horizontal or perpendicular movements result in earthquakes in or on the peripheral districts of such cities, consequently a demanding need arises for probing into and analyzing the Bam earthquake and its immediate aftermath with regard to natural and general factors that have perpetrated heavy loss of human lives and property. Similarly identifying geomorphological phenomena resulting from such factors can be realized accordingly. It is suggested that greater attention should be paid firstly to the location of cities and identification of faults and secondly the construction of resistant buildings without neglecting scientific standards in this regard.

2- Materials and Methods:

Keeping in mind the available means, substantial consideration has been accorded in the research under discussion firstly towards the grounds of seism city of the country as well as to the buildings being non-resistant to earthquakes, and then it has been ventured along with investigating into geomorpholigical phenomena actuated by the said earthquake, to consider the compelling factors and causes leading to high death toll and heavy loss of property as compared with other earthquakes taken place in Iran and other parts of the world on the whole ,while making best use of the field experiences, field checking of the earthquake-hit district (three times traveling with undergraduate students touring the area, two times with graduate students and once with a group of visiting faculty-members from the Geography, Civil Engineering and Geology Departments of the university of Sistan and Baluchestan in the earliest weeks of the earthquake), study of satellite images, 1:10000 aerial photos of the affected areas, snapped only two days after the mishap occurrence by the National Cartographic Center of Iran (NCC), 1:250000 geological map of the region, furnishing of a photograph-album containing more than seven hundred digital photos. Therefore, the research procedure of the article in hand pertains mostly to the field work and direct and indirect observations.

3- Introduction:

The geologic constitution of the Iranian plateau and its peripheries pertain to the geological system of the Tertiary folded belt, which from the mineral deposits and economic point of view is a potential and positive factor, while from the seism city tremors point of view, it is a negative factor (Ramezani Gorabi, 1994, p107). Our country lies on the middle of the Alpine Orogenic belt the movements of which have so far not been completed; hence the ultimate equilibrium has not

been achieved. Therefore, bearing in mind the location of Iran and its lying in between the two old continents that is Eurasia to the north, and Africa-Arabia to the south, it has become a fragile and brittle platform; the active and frequent faults and subsequent earthquakes all speak for the assertion. All in all there are three seism city zones in Iran, viz. Zagros, Alburz and Central Iran. The Arabian plate from southwest, India from east and southeast and Siberia from northeast administer immense pressure on Iran. Iran's resistance against forced pressure has resulted in several faults and fractures in Iran; while the activities of such faults have virtually turned Iran into one of the principal seismic zones of the city. Consequently, the energy, thus raised by pressure in faulting zones, bursts out in the form of catastrophic earthquake-waves which then culminate in annihilating and wiping out towns and cities. Earthquakes are activated in Iran by the movements of such faults. Since the relief's in Iran are reasonably young and are located in the core of the ultimate orogeny belt of the earth planet (Alpine) and since they lie in between tectonic plates, hence from the earth's structural point of view and as a result of seismic movements, they have not yet come to a standstill. Therefore, to gain isostasy equilibrium, they have to continue to be active (Zamorodiyan, 2002:121).

Since Iran stands on one of the two seism city belts of the globe as well as the presence of ample faults, the occurrence of earthquakes in the Iranian plateau is but a natural phenomenon. Around four to five thousand human lives, on average, are annually lost in the earthquakes in Iran. As such it has to be admitted that Iran stands amongst the ten catastrophic countries and ranks the sixth among the cities prone to seism in the world, hence resulting in massive proportions of loss of life. The seismic belt encompasses ninety percent of the country's land. Out of forty types of natural disasters, thirty-one have been experienced in Iran. Bam earthquake, being the severest one in Iran in the recent times cannot be singled out in this respect. All in all, it has now become more prudent not to be negligent of the menaces of such natural adversities.

Discussion:

Perhaps earthquake can be termed as the most doleful and horrendous natural disaster that threatens most of the third world countries. The presence of fractures and faults in the continental blocks are amongst the factors in whose stretches the intra formed energy gets released and thus usually leads to earthshaking in the peripheries. Therefore, identification of the available faults in every country and their being young and active helps, to a great extent, in avoiding them (Ramesht, 1990:42).

One and a half years have passed since the ruinous Bam earthquake unmasked its ugliest countenance. It augured badly to one and all that in view of the physical geography of Iran, most parts of it are threatened by earthshaking; as such careful consideration should be awarded to masonry rigidity of our dwellings. As far as the Bam murderous earthquake is concerned, it is established that because of the crumbling of traditional mud-brick and clay homes, the movements

and surface waves of the Bam earthquake inflicted the heavy casualties. Sadly, the apprehension of the earthquake prevails all over the country. This calls for serious consideration for the tumbling down-towns and villages by the government in order to shun the hideous recurrence of such an adversity.

Nearly 80% of the buildings in the country are vulnerable to severe earthquakes. Out of nearly twelve million houses, about seven million two hundred thousand houses lack sufficient resistance. There are around four million rural dwellings with traditional mud-brick and clay construction bearing little resistance capability against earthquakes.

Low-quality construction-materials, types of houses, absence of appropriate patterns, dearth of earthquake-resistant constructions and deteriorating state of buildings, etc are only some of the factors that forecast the impending disaster. The majority of the construction contractors are devoid of construction standards. Besides, the supervising engineers pay little attention to construction supervision. All in all to combat imminent threats of earthquakes, nothing but of building strong constructions can defy the miseries and widespread destruction of the earthquake.

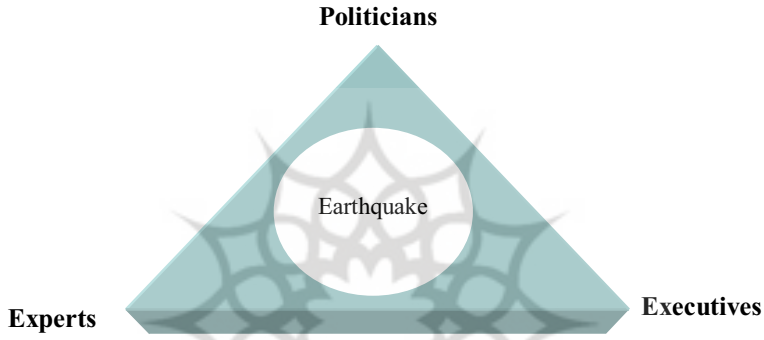
(Fig1): The five-storey newly constructed building in the Bam city, which Was ravaged by the recent earthquake A review at the statistic and record of the natural disasters reveals that, in Iran, the earthquake phenomenon is an identified one, which puts to death hundreds of people every year and after a certain span of several years, devastates some districts of the country, annihilates thousands of people, razes numerous dwellings to the ground, and leaves untold number of people homeless and jobless.

4- Bam Earthquake Analysis:

The Bam earthquake can be analyzed and investigated from different points of view, and the results thus obtained can consequently depict heterogeneous outlooks for disciplines of science. Barring scientific and systematic analyses, the sufferings of the incident were so much agonizing and horrendous that made one and all grief-stricken and heartbroken. The ever-present question: “why all these losses of life and colossal damages of

property are caused by earthquakes only in Iran, while comparatively more severe earthquakes shake ruthlessly other countries, for instance Japan, where death toll and material loss is strikingly normal?" perpetually looms over the minds of most of people in our country.

It seems as if it is an annular earthquake the repercussions of which spring from the performance of three groups namely: politicians, experts and the executives. Hence, if the trio is equipped with necessary mutual harmony, executes its plans competently and moves in line with the scientific standards, the miseries of the earthquakes can substantially be reduced, otherwise the earthquake can wreak havoc on human lives and material properties.



(Fig 2): The rate of earthquake-devastation depends on the performance of the three Groups: politicians, experts & executives.

The outcome of the aforesaid harmony is befittingly depicted in the following comparison; for example, the earthquake which, measuring 8.8 on the Richter scale, shook the eastern region of Hokkaido Island in the north of Japan at 5 early on the Friday morning 26th of September 2003 with a ravaging force equivalent to that of 512 atomic bombs, took the life of merely one person whereas two persons were missing and six hundred people received injuries. But why on the face of such a negligible measure of loss, the earthquakes measuring 5 to 7 on Richter Scale claim twenty to thirty thousand loss of human lives in our country? Have we ever mulled over the matter? And, have we ever bothered to devise some worthwhile strategy to combat the menace?

Indeed, why did the Bam earthquake claim so much loss of human life and property?

Frankly speaking, there have been severer earthquakes so far in Iran but none of them had played such havoc on human life and property. In Bam, this may be due to the following factors: (1) very shallow focal depth, (2) significant local effect at the epicenter and high absorption of energy by soft sedimentary rocks on a regional scale, and (3) the type of buildings and structures, which are mostly one or two story and could resonate with high

frequency earthquake waves in the vicinity of the source(Ramazi and Soltani 2006). The highest death toll and loss of property that ensued Bam earthquake emanated from two cardinal and vital inducements each of which has its own crucial and influential effects. The two factors have been termed as natural and general in this paper:

4-1 -General Causes:

4-1-1 - Earthquake Occurrence Time:

The Bam earthquake took place exactly at 5:26:26 AM at dawn on December 26, 2003, when most of the many residents were still in their beds. Hence, it can easily be figured out that if the earthquake had occurred on a day other than Friday (the weekend holiday), and during any time of day when the people were awake or were at work or happened to be in an open space, then definitely the magnitude of loss of human lives would have been considerably less damaging as compared to the present one. In terms of human cost, the Bam earthquake ranks as the worst recorded disaster in Iranian history; a tragic statistic in a nation already ranked as the World's 4th most disaster- prone country (IFRC, 2004).

4-1-2- Earthquake Duration:

The earthquake that destroyed Bam city and its peripheral rural areas is estimated to have lasted for twelve to thirteen seconds which is comparatively a longer period and thus becomes one of the factors for claiming higher loss.

4-1-3- Earthquake Occurrence Season:

The Bam earthquake occurred in winter, when people were asleep in their houses. If the earthquake had happened in summer, the casualties would have been quite fewer as compared to the present one since the people according to an old tradition prefer to sleep in the open spaces of their inner courtyards in summer.

4-1-4 - Historicity of Bam:

The historic city of Bam, the ancient citadel (Arg e Bam) of which is globally renowned for being the world's biggest mud-brick and clay construction, still upholds the traditional and primitive structure. Many of the houses had been mud-brick with little consideration for technical and engineering priorities. Such a status was one of the factors for bringing on the higher loss of life and demolition of a major segment of the city.

4-1-5 - Damages to Relief Places and Public Organizations

Most of the schools, hospitals, and emergency buildings collapsed. Underground pipelines and water supply system were totally destroyed. The electricity and telephone lines were disrupted.(Ramazi and Soltani 2006) Right from the outset of the quake occurrence, the bulk of the relief organizations including Red Crescent, military garrisons, hospitals, Fire Brigades, drugstores, municipalities, the administration authority, etc. which should have been implementing relief activities, became the victims of the earthquake and bore the brunt of the catastrophe by the loss of lives and ravages of their establishments. Therefore, if this tragedy had not taken shape in the described

manner, no doubt the rate of casualties and damage of property would have definitely been far lower than we had experienced.

4-2 – Natural Causes:

Pragmatically speaking, there are certain factors that are quite effective in the intensity of an earthquake. They include the quake severity, the distance from the epicenter, geological variations all along the path, type of fault, and stress conditions, etc. (Sa´edi Bonab, 1999, p101). These factors are investigated and analyzed in the Bam earthquake phenomenon, as under:

4-2-1 - The Epicenter Location:

The coordinates of the epicenter of the Bam event are determined as 58.27E and 29.01N by the USGS (2003) and lying at a distance of ten kilometers to the southwest of Bam city (Amini Hosseini, et al, 2003, p2) but the reconnaissance team from the International Research Institute for seismology & Earthquake Engineering has identified the earthquake epicenter, on the basis of superficial evidences, right underneath the Bam city.

4-2-2-Focal Depth of the Earthquake:

The earthquakes rarely occur on the earth's surface; rather they take place in the depths of the earth. The spot from which seismic energy diffuses around is called the epicenter of the quake (Moayeri, 2002, p103).

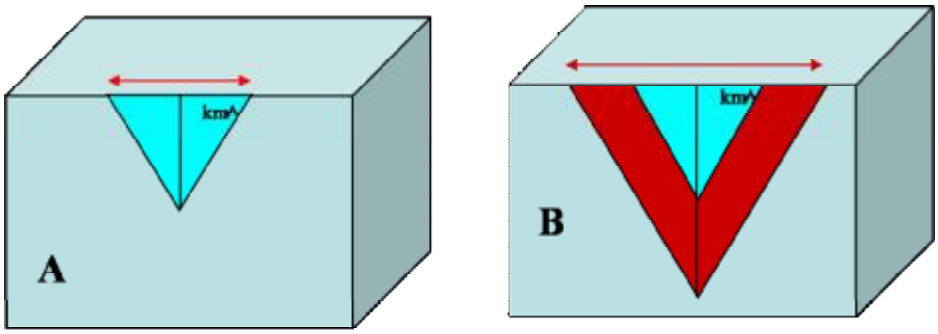
On the basis of available statistics, it can be stated that 80% of earthquakes in Iran have occurred at a depth ranging between zero to fifty kilometers, 12.5% have taken place at a depth of more than fifty kilometers while 7.8 % of the quakes have not been taken into account (Darveishzade, 1991, p807). Therefore, the earthquakes taking place across Iran have usually been with normal depths (nearly 32 kilometers), whereas an earthquake with a depth of more than fifty kilometers has rarely occurred in our country.

Keeping in mind that the epicenter depth of the Bam quake has been calculated at eight kilometers, hence the earthquake has absolutely been superficial containing high proportion of ruination force (Fig. **A**) since the superficial earthquakes are literally endowed with higher devastating force, however, with the increase of the epicenter depth, the severity of the earthquake decreases but the range of it increases (Fig. **B**)

A preliminary analysis of the TS–TP of the recorded strong ground motion data also suggests a focal depth of around 7G2 km.(Ramazi and Soltani 2006) For example, the recorded accelerogram in Bam shows a TS–TP value of about 1 s (BHRC, 2004), which indicates a very shallow earthquake.

4-2-3 - Earthquake Magnitude:

Although the magnitude of Bam earthquake has been read 6.5 on Richter scale, its destructive potency, by virtue of its superficial epicenter, has been quite enormous. The following table depicts a comparison among the few high-magnitude earthquakes in the recent decades in Iran.(Table 1)



(Fig 3):The diagram blocks of superficial & subjacent earthquakes, with the increase of the depth, the Seismic-hit area also increases.

Table1: comparison among the few high-magnitude earthquakes in the recent decades in Iran (IIEES 2007)

Earthquake-hit region	Occurrence date	Earthquake magnitude on Richter Scale	Rough estimation of casualties in thousands
Seilakhore	February, 1908	7.4	8000 persons
Daragaz-Kalat	1929	7.1	3253 persons
Salmas	May, 1930	7.2	2514 persons
Laar	May, 1960	6.1	15000 persons
Boinzahra	1st sep, 1962	7.2	12000 persons
Dasht-E-Biyaz, Khorasan	August, 1968	7.4	12000 persons
Qeer-O-Karzeen	March, 1972	7	5000 persons
Bandar Abbas (Sar khoon)	March, 1974	6	6000 persons
Tabas	September, 1978	Between 7.5 to 7.8	20,000 to 25,000 persons
Sierch Kerman	Summer, 1981	7.3	1300 persons
Roodbar & Manjeel And others	21 June, 2000	7.3	32,000 to 35,000 persons
Bam & Baravat	26 Dec, 2003	6.5	Nearly 30,000 persons
Surrounding villages of zarand	5 March, 2004	6.4	Nearly 500 persons

Therefore, as is displayed in the above table, although the Bam earthquake magnitude has relatively been lower than those of Seilakhore, Daragaz-Khalat, Salmas, Tabas, Boinzahra, Dasht-e-Biyaz Khorasan, Qeer-o-Karzeen, Sierch Kerman, etc, it has claimed higher number of casualties and extensive damage to property.

4-2-4 -Genuine Cause of Bam Earthquake:

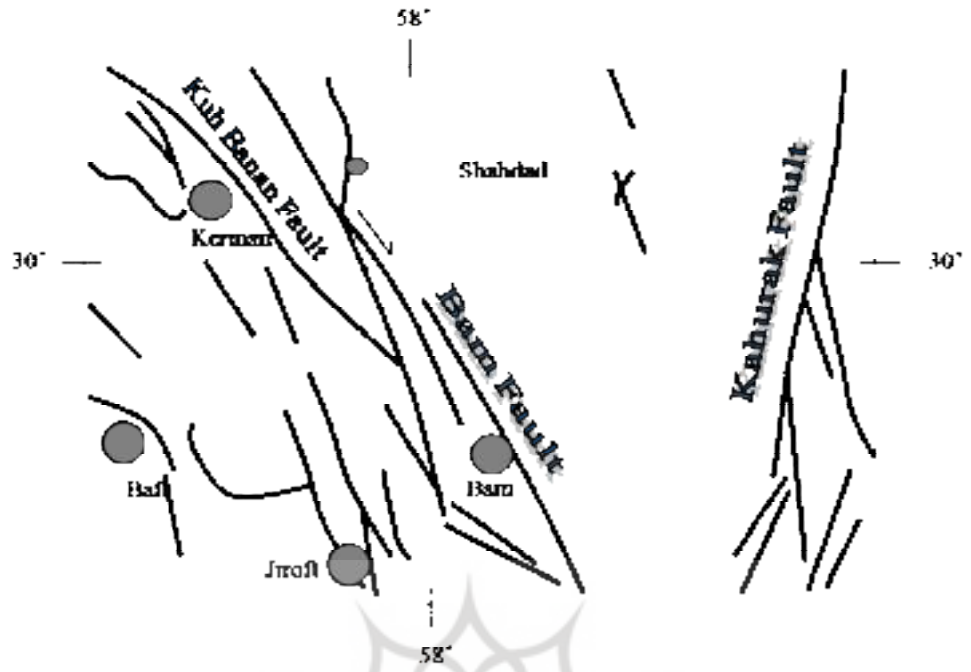
According to a speech by Dr.Ghafoori Ashtheyani, the Head of the Iran Institute of Seismology (reported by the" news network of IRIB" on the first of January 2003), the genuine cause of the Bam earthquake has been the activation of the Bam or probably Gowk or Golbaf faults. The true direction of the Bam fault, lying between Bam and Baravat, is approximately northern-southern, whereas the direction of its last activation has been determined towards northeastern-southwestern. The normal movement of this fault is a right-lateral strike-slip (walker & Jackson, 2002,
p1680), but in the last earthquake, in addition to horizontal movement, there have been lateral and perpendicular movements which aggravated the scale of destruction in the region.

4-2-5-Bam Fault Activation:

The length of the Bam fault has been determined to be one hundred and sixteen kilometers out of which only thirty kilometers of the fault have been active in the last earthquake. It is believed that for the last couple of thousand years, the mentioned fault has had no cataclysmic activation since the historic Bam mud-brick citadel's (Arg-e Bam) standing intact substantiates the assertion. There is no mention of earthquake occurrences around Bam city in the Iranian historical catalogue (Ambraseys and Melville, 1982). It seems that it was the first time during the last 2000 years that a catastrophic earthquake has taken place due to reactivation of the Bam fault. The Bam fault had crossed the Quaternary sediments before the earthquake. **(** Ramazi and Soltani 2006**)**

4-2-6 - The Earthquake Dimensions:

Virtually, distant location from the epicenter causes a more moderate destruction. However, since the Bam earthquake had been less deeper and absolutely superficial, the ravaging magnitude had been higher, though its domain had been smaller. A stretch with nearly thirty kilometers (approximately northern-southern) length and about twenty kilometers' (roughly eastern-western) width was devastated from sixty percent to hundred percent.



(Fig 4): Bam Fault and its remaining peripheral faults.

4-2-7-Bam City Distance from the Fault Location:

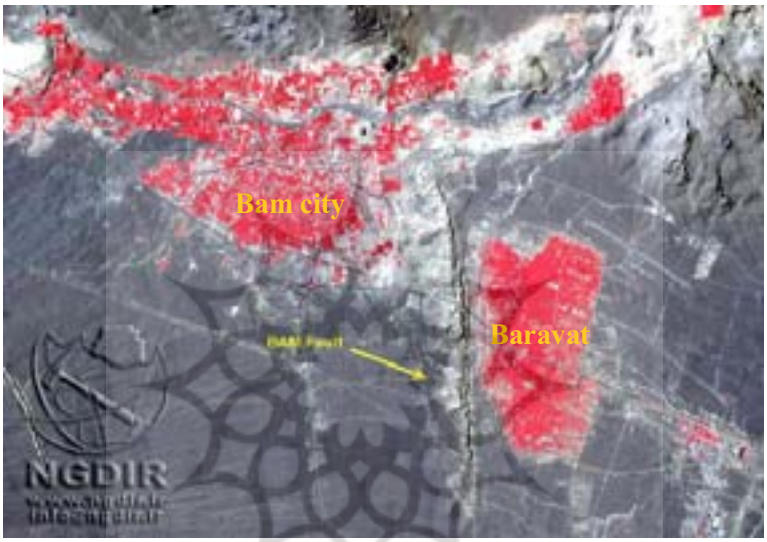
Unfortunately, the bulk of populous regions of our country lies on the seismic zone since most of the large cities have been set up at elevations that have been detached by bigger faults, probably global ones from the plain. Regarding the locality of small cities and towns, the primary inducement for their establishment there has been the springs and other water resources which shoot up mainly from fractured and fault zones; as such most residential districts are situated within the fault tracts.

Sometimes, the distance between the faults and cities is so much short that the fault borrowed their names from the cities and settlements. They include among others Tabriz, shahr-e-Rey, Gorgan, Bam, Neikshahr, etc (Negaresh, Khosravi, 1998, pp 123 to 128).

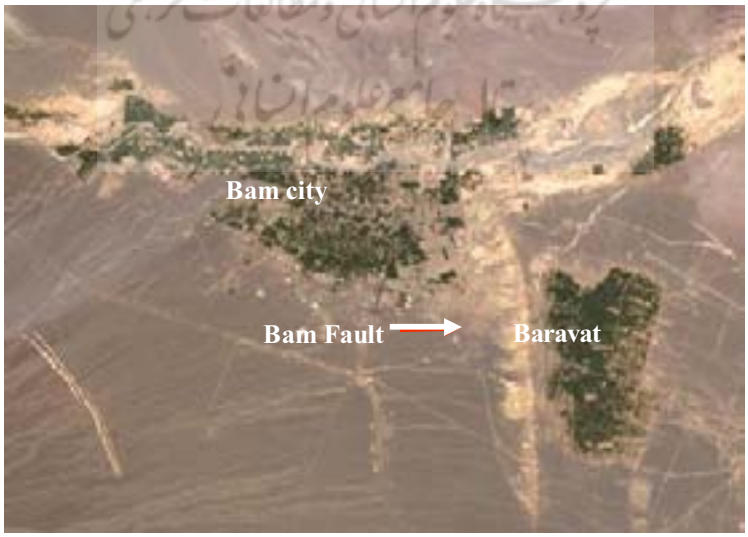
The Bam city came into existence near the Bam fault during the past ages. In recent centuries, it has received greater expansion and gradually the Bam city to the west and part of Baravat to the east of the fault got expansion and development which increased day by day, as a result of which parts of the fault had been covered by the buildings of the city prior to the occurrence of the last earthquake.

As is evident, if the distance between the city and the fault, ranges from zero to

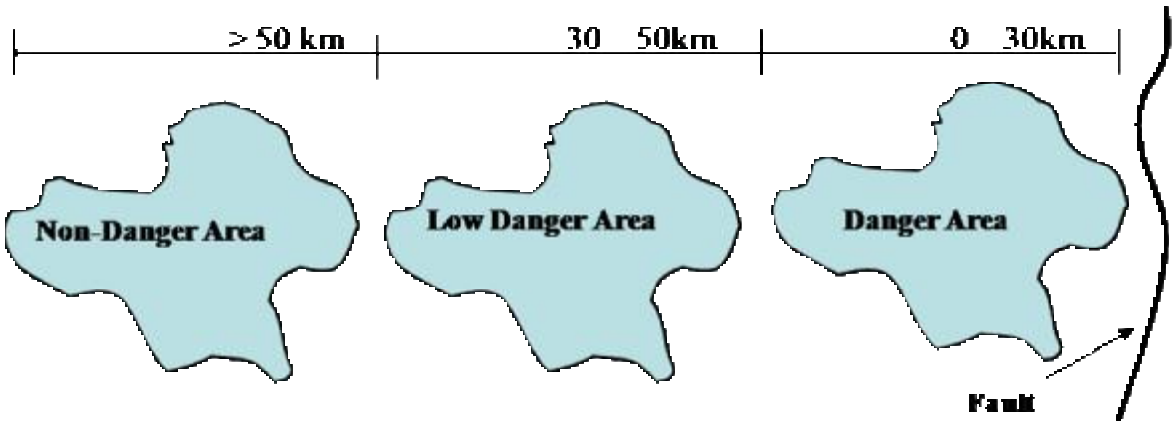
thirty kilometers, the area is termed, from the seismic point of view, as 'hazardous'; if the distance falls between thirty to fifty kilometers, the region is called 'less hazardous', but if the distance exceeds fifty kilometers, the area is considered to be 'out of danger' (Pour Kermani & Arien, 1997, p179). Consequently, since Bam and Baravat settlements are built on the brink of the fault, they are definitely hazardous regions and the following hypothetical model manifests the point quite elaborately.



(Fig 5): Satellite image developed by ikonos, displays the distance between Bam city, Baravat District and the Bam fault (Source: National Geosciences Database of Iran).



(Fig 6): Ikonos satellite image, displays the distance between Bam city, Baravat district and the Bam fault.(Source: National Geosciences Database of Iran)



(Fig 7): Hypothetical model of cities' structures on the fault's fringe having consequential hazards.

5-Geomorphological Traces & Evidences Resulting from Bam Earthquake:

Principally, earthquakes occurring on the earth's surface generate numerous geomorphological traces such as: faults, horizontal and perpendicular dislocations, fractures having varied dimensions, stimulation and acceleration of the materials movement on slopes, blocking and changing of the streams' passage, running and blocking of water-springs, and tsunamis etc. therefore, earthquake, directly or indirectly, renders environmental instability (Zamorodiyan, 1999, pp. 39-42), and keeping in view the type of geological formations of the earthquake-hit area, dip slopes, earthquake intensity, environmental instability rate, etc. bring about new landforms.

Since the kind of most of the geological formations of the earthquake-hit area of Bam consists of quaternary alluvial deposits (ancient and recent), exogenic igneous rocks of Eocene and granodiorite (Bam geological map 1:250000), consequently the resistance against earthquakes has not been sufficiently intensive for which various fallings and slidings in the area (nearly six to seven thousand cases) corroborate the theme.

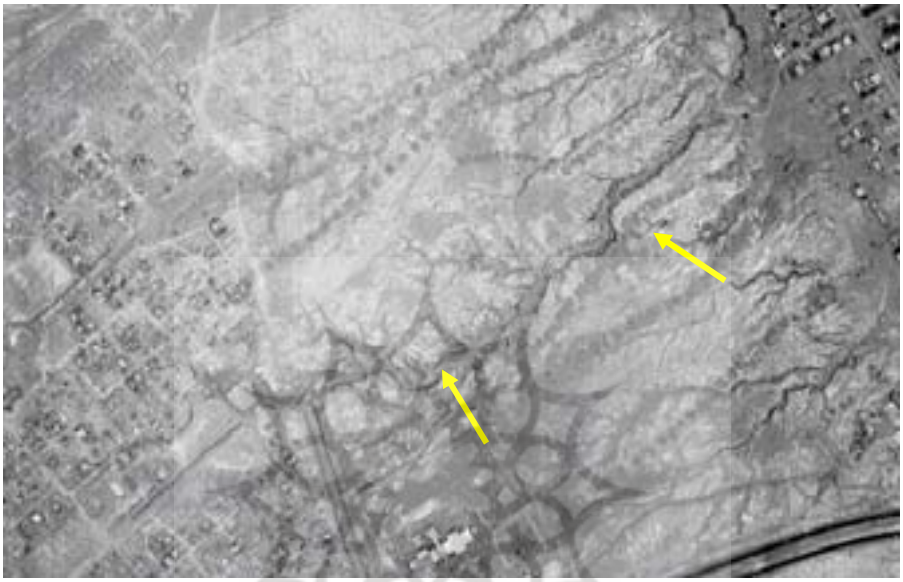
Some of the geomorphological phenomena generated in the region by the Bam earthquake include different falling and land slidings, earth subsidence, superficial tensile cracks etc, which are described as below:

5-1-Landslides:

One of the most significant landforms brought about by the Bam earthquake has been the landslides which can be seen in the fringes of the available gullies of the quaternary alluviums since the quaternary alluviums couldn not take shape of diagenesis (lithification) and since most of them are of the sand-deposit, silt and marl kinds, they couldn't stand against the shaking of the earthquake, and since

the epicenter of the seism lay right underneath the mentioned deposits, they had been unstable, consequently minor and major slippings have taken place in them.

The slides are mostly observed in the dune-bedded lands and on the edge of gullies (stretching west to east) crossing the northern-southern Bam fault somewhat from west to east. The earlier slides have been of the kind of block slides with high compaction from south to east (between Bam and Baravat) and on the northwestern portion of the Bam city. The approximate number of slides induced by the Bam earthquake has been, by using model statistics, assessed fifteen landslides and fifty-five block landslides (Amini Hosseini, et al, 2001, p13).



(Fig 8):Location of some of the land slides on the aerial photo 1:10000 of the area taken by the National Cartographic rganization of Iran .

5-2-Rock Falls:

Rock Falls are one of the leading geomorphic phenomena, resulting from the Bam earthquake, which, like landslides, have often occurred in the quaternary deposits. Because of the unstable deposits the phenomenon has taken greater shape than the other geomorphic phenomena in the Bam earthquake-hit area. This phenomenon is quite prominent in the east, south and northwest of Bam and in the west of the Baravat district.

The Rock falls that have taken place in the region are probably of the kind of rock-falls and soft-falls.

The rock-falls have mostly occurred in the silt and marl formation. Some of their dimensions have been estimated at ranging between two hundred and two hundred fifty cubic meters.

But, some of the falls have occurred in the quaternary gullies and soft-sand lands, which, in any way, are not rocky. The approximate number of falls, using statistic model, happening due to the Bam earthquake has been determined at about six thousand cases.

(Fig 9): The rock-falls in the west of Baravat (northwestern of the photo) and Southeastern of the Bam city

(Fig10): The loose falling in soft-sand deposits in the west of Baravat and southeast of the Bam city.

5-3-Land Subsidence:

Yet another striking geomorphological phenomenon generated by the Bam earthquake in the region, is the Land subsidence which might have cropped up in the urban and rural districts as well as in the perimeter of the city. Some of the subsidence had also entailed certain demolition and damages, including crumbling of subterranean-water-canal kilns, well shafts, tearing down of roads, demolishing of buildings and residential

quarters, etc. a lot of sufferings and hardships pertain to the primitive subterranean-water canals which, with the passage of time, had sunk and lost their ground-surface traces with the result that building and construction work had been carried out over such sites. This state of affair had caused severe land subsidence because. The seismic vibrations and dislocation of the dismembered empty spaces of the well-shafts commonly sunk in the deep had developed the land subsidence (Amini, Hosseini, et, al, 2003:20). In some other areas, the land subsidence had occurred because of the crumbling of the subterranean-water canals which can be witnessed in the form of minor and major sinkholes with dimensions of several meters. The land subsidence can be seen more prominently in the peripheries of Bam fault than the other sites, in a manner that the phenomenon has taken the shape of a cave in the fringes of the land surface. With the increase of distance from the Bam fault, the shape can hardly be witnessed. In the early days of the earthquake, certain sinkholes had caused communication disconnection and vehicular traffic disruption along with the subsiding of courtyards of some of the residential houses and demolition of various buildings.

(Fig11): Sand deposits subsidence in the west of Baravat and southeast of the Bam city.

5-4-Earth Surface Tensile Fissures:

The suction strokes and numerous shakings by the Bam earthquake led to the creation of a series of minor and major discontinuities and fissures in the surface of the earth, the dimensions of some of them have been assessed to be tens of meters long, numerous meters wide while some of them having several meters depth. These fissures and fractures are usually oblique or vertical tending towards Bam Fault and end on the cliff of it in a way that in fact it looks like branches of a tree whose stem is the Fault of Bam.

It seems as if the fissures would be the causes of enhanced erosion and environmental instability in the future (for instance, permeation of water into the lower strata and …) and consequently would ensue the generation of new landforms.

(Fig12): One of the fissures and fractures of the earth surface in silt deposits with easterly-westerly Direction lying to the west of Baravat and southeast of the Bam city

CONCLUSIONS:

The occurrence of numerous earthquakes in Iran manifests:

1) Since Iran is situated on the earthquake belt having a myriad of faults, consequently the fault activities and the recurrence of earthquakes in the country are in any way inevitable.

2) Iran is one of the ten calamity-ridden and the sixth in the row of seismic countries of the world, where the earthquake factor breeds the primary cause of high loss of human life. Moreover, the earthquake belt encompasses ninety percent of the country's land.

3) Earthquakes shaking Iran are mostly superficial with a high frequency of devastating force.

4) It is necessary to be made obligatory not to build towns and cities on the brink of faults in accordance with the legal distance. This is because the fault activation brings about death and destruction in its wake on the cities and towns within its realms thus vehemently rejects the extension and expansion of such buildings as seen economically.

5) Majority of the existing buildings are of an old nature as well as non-resistant. Therefore, the buildings should be resistant and assuredly safe and stable

in the face of seismic activities. The construction material should be of a special kind having the essential characteristics of being light and resistant.

6) There is an urging need for a greater supervising and controlling attention towards the construction state of affairs. As such, construction work should be carried out only through authorized experts bound by legal obligation and under the strict supervision of relevant quarters, while completely eliminating the profiteers and opportunists in this field. The engineered structures, constructed according to the seismic code of Iran (Standard 2800 of Iran), have shown very good structural behavior without any significant damage.

7) Due care should be paid to the site-selection for town-building which must conform to the construction rules and regulations as well as coping with scientific standards.

8) Constructing resistant buildings by public and private sectors against the threats of faults and earthquakes is a matter of national determination as against a house-building division.

9) Poverty induces unsystematic suburban-house building by neglecting all construction standards and utilizing low quality construction-materials. Such a trend paves the way for unpredicted colossal catastrophes.

10) The level of public knowledge about faults and earthquakes specifically their types and activity trends should be increased and widened on the one hand, and, on the other, constructing resistant-buildings encouraged and augmented. It should also be made known to the public that making buildings resistant entails far less expenditure as compared to their embellishment cost.

11) No part of our country could be a safe haven as against severe earthquakes. Hence both people and authorities should sincerely acknowledge the very existence of seism city and as a result should endeavour to lessen the scale of casualties and loss of property by constructing earthquake-resistant buildings in accordance with technical and engineering established norms and notions framed by construction industry.

12) Nearly eighty percent of the building now standing in the country is no doubt vulnerable to severe earthquakes; out of about twelve million residential units, almost seven million and two hundred thousand units are inadequately resistant in the face of earthquakes. Moreover, there are nearly four million rural houses with crumbing mud-brick construction lacking essential

safety and resistance measures for encountering any earthquake hazards.

13) The Tabas-earthquake mishap pragmatically sank beneath the throes of the Islamic revolution commotion. Besides, Roudbar and Manjeel earthquake disaster was consigned to oblivion because of the perplexities being encountered in the reconstruction and rehabilitation of war- torn districts. It is expected that the two mentioned incidents would be reasonably enough for teaching the concerned quarters a lesson not to remain aloof of or become indifferent to Bam earthquake merely on the pretext of political tensions and election campaigning.

14) The siting of the historical city of Bam on the margin of fault in olden days and its further enlargement during recent years eventuated in escalated human loss of life.

15) One of the paramount causes of inflicting irreparable losses of human life and property in the Bam earthquake has been Friday- a weekly off, strictly observed both by public and private institutions all over the country; the time of occurrence has been before sunrise, while the season of the year has fallen in winter. All the said factors have gone hand in hand to make people feel at home and lay in beds within their rooms at those hours of the early morning.

16) Recounting other active factors running in the forefront of raising the ratio of loss of life could be attributed to the earthquake epicenter lying right beneath the Bam city, superficiality of the earthquake, seismic intensity, earthquake occurrence elongation, etc.

17) In short, Bam earthquake was a bitter and vehemently heartrending experience in which thousands of our compatriots either lost their precious lives or sustained serious injuries. However, it is neither the first nor the last episode of the play. By and large, we have gained some fruitful experience from recent earthquakes particularly the calamitous Bam earthquake. In due course, we have realized that we lack a substantial portion of the knowledge; we understand that we mostly contemplate objectively, whereas at the time of mishap-occurrence we become much passionate and immediately resort to slogans, but with the receding of the din and commotion, gradually consign it to oblivion.[1] We have learned not to make optimum use of the present-day advanced technical know-how; and we have also become aware of the fact that our exigency

1-For example, nearly fourteen years ago, a debate ensued in Tehran on the burning issue of shifting the capital to another site because of the existence of myriads of faults and thereby the likeliness of earthquakes; but regrettably to say that the issue fell into oblivion. However, the Bam tragedy has once more reminded us of the issue.

administration is poorly equipped with discipline and coherence characteristics; rather it has fallen into a state of crisis.

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