Earthquakes and Project Management Utilization: A Case of Recent Earthquakes of Iran

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Abstract

Iran is located in a very complex tectonic environment; it has experienced more than 25 strong earthquakes with a magnitude of 6 or more in this century. The huge earthquakes in the century have killed more than 170,000 lives, destroyed many towns and thousands of villages, and caused extensive economic damage. The research contrasts the fatalities and destruction of some of the greatest earthquakes of Iran and other countries from 1950. The results show the deaths and disasters of earthquakes in Iran are 23 times more than the theoretical expectation. On the other hand, comparison of recent records on the impact of earthquake hazards of similar magnitude in countries of varying levels of development and Iran make an astonishing result.

Comparing California's damages to construction after the past earthquakes with Iran's disasters of earthquakes in same magnitude suggests that poor construction practice and lack of effective project management utilization played major roles in the vast destruction and high death toll and sorrowful tragedies within the cities of Iran.

Despite the history of tragic earthquakes, and their continuing recurrence in Iran the study aims to make the government, companies and managers of disasters aware of the aftermath in different parts of Iran of low quality construction and lack of project management knowledge utilization; and make a consciousness for applying proper ways to prevent probable damages in future.

Keywords: Iran, California, Earthquake, Project Management, Building Quality, Destruction, Fatalities.

1.0 Introduction

Iran, being situated in the active Alpine-Himalayan seismic belt, which is one of the most active tectonic regions of the world, is an earthquake prone country that has experienced more than 130 strong earthquakes with a magnitude of 7.5 or more in past centuries. In the last few decades, around 25 huge earthquakes have killed more than 170,000, destroyed many towns and thousands of villages, and caused extensive economic damage (Ghafory-Ashtiany and Eslami, 1997; Mehrabian et al., 2005; Akhavan, 2006). According to Table 1, statistics of the last few decades' earthquakes in Iran have shown seismicity of Iran as well as its vulnerability to earthquakes. Figure 1 indicates the location of some of these earthquakes. According to Ghafory-Ashtiany and Eslami (1997), the malfunction of structures for most of the earthquake areas were mismatched with the level of earthquake hazard that caused serious human and economic losses.

Table- 1 – A brief history of huge earthquakes of from 1957

No.	**DATE**	**Magnitude (Richter scale)**	**Location**	**No. of Dead**
1.	07/02/1957	7.4	Northern of Iran	2,000
2.	12/13/1957	7.3	Hamadan and Kermanshah	2,000
3.	09/01/1962	6.9	Buin-Zahra, Qazvin	12,225
4.	08/31/1968	7.3	Khorasan	12,000 - 20,000
5.	04/10/1972	7.1	Southern Iran	5,054
6.	11/24/1976	7.3	Northwestern Iran	5,000
7.	03/21/1977	6.9	Bandar Abbas	167
8.	06/07/1977	6.5	Isfahan province	352
9.	12/21/1977	6.2	Zarand in Kerman Province	521
10.	09/16/1978	7.8	Tabas	25,000
11.	1980	5.6	Ghaen	1,500
12.	06/11/1981	6.9	Golbaf (Kerman Province)	3,000
13.	07/28/1981	7.3	Kerman Province	1,300
14.	03/141989	5.4	Golbaf (Kerman Province)	5
15.	06/20/1990	7.4	Rasht-Qazvin-Zanjan- Rudbar-Manjil	40,000 -50,000
16.	06/21/1990	5.8	Lowshan-Manjil	20
17.	02/04/1997	6.5	Bojnoord	100
18.	02/28/1997	6.1	Northwestern Iran	1,567
19.	05/10/1997	7.1	Ghaen-Birjand	1700
20.	06/22/2002	6.5	Western Iran	261
21.	12/26/2003	6.6	Bam	31,000-43,000
22.	2/ 22/2005	6.4	Central Iran, Zarand	612
23.	01/31/2006	6.1	Darb_e_Astaneh (Western Iran)	66
Total people approximately killed during above stated earthquakes				**175,450**
Total people left homeless following above stated earthquakes				**750,000**
Total estimated damages				**Several billion USD**

Earthquakes Location

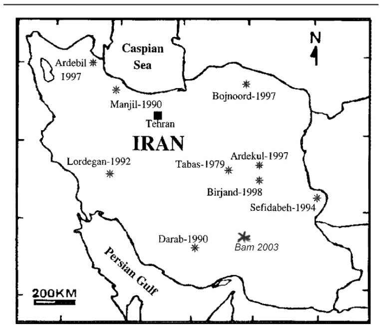


Figure 1 - Location of the largest earthquakes of Iran

2.0 Some of the Great Earthquakes of Iran

Iran is located in a very complex tectonic environment, where shortening takes place due to Arabi-Eurasia convergence and many destructive earthquakes have occurred in past centuries. Deformation and seismicity in this region is mainly due to the continental shortening between the Eurasian and Arabian plates. Seism-o-tectonics of Iran as a part of the Alpine-Himalayan orogenic belt has been the subject of several researchers (Nowroozi, 1972; McKenzie, 1972; Jackson and McKenzie, 1984); and the historical earthquakes of the Iranian plateau have been studied by some investigators (Ambraseys and Melville, 1982). Here is a brief explanation of the significant historical earthquakes of Iran.

2.1 Tabas Earthquake

On the 1978 September 16, Tabas was destroyed and 85 percent of its population killed by an earthquake of Ms 7.8 that remains one of the largest instrumentally recorded earthquake in Iran. Most of the constructions were adobe buildings and lack of good quality material and design, and low construction quality and control were observable in destroyed buildings (Walker, et al., 2003).

2.2 Golbaf Earthquake:

The Golbaf Earthquake in 1981 (Ms 6.6) destroyed Golbaf City and surrounding villages with 3,000 deaths and more than 4,000 injured and produced a 15km surface rupture. This earthquake was followed a month later by the Sirch Earthquake (Ms 7.1) with 65km of discontinuous surface ruptures that destroyed Sirch and the surrounding villages with approximately 1300 deaths. The lower magnitude of South Golbaf Earthquake in 1989 (Ms 5.8) had much reduced consequences with 4 deaths and 45 injured. Similarly the Fandoga (north Golbaf) Earthquake (Ms 5.4) was associated with 5 deaths and about 50 injured and ruptured along a 20km section in northern Golbaf (Beberian, et al., 2001; Eshghi and Zare, 2003; and BHRC, 2004).

2.3 Rudbar-Tarom earthquake

During the June 20, 1990 Rudbar-Tarom earthquake (Ms 7.4) in northwest Iran, more than 40,000 people lost their lives, more than 500,000 became homeless, nearly 100,000 buildings were destroyed, three cities and 700 villages were razed to the ground. Such great disaster occurred not only because of a large magnitude earthquake but also because of the poor construction and preparation in vulnerable areas. Reconstruction of the region was estimated to cost at least 2.8 billion dollars (economic losses inflicted by this earthquake were estimated $ 7.2 billion, with 7.2% in GNP loss). The long-term effects of this catastrophic event included the disruption of the economies of at least three large provinces, and the human resettlement of at least three large cities and 700 villages; reconstruction to modern standards has taken decades to accomplish and absorbed a considerable part of the country's budget (www.iiees.ac.ir/English/eng_index.html).

2.4 Ghaen-Birjand

On May 10, 1997 an earthquake with magnitude Ms 7.3 (USGS), 7.2 (Harvard), 7.7 (USGS), and 7.2 (Berkeley) occurred in the Ghaen-Birjand region in northeastern Iran. As a result of the recent earthquake, 1,700 people were killed, and more than 2,300 were injured. In addition, 147 villages experienced damage. Some of these villages were completely destroyed while many others suffered heavy damage, especially to housing units (Allamehzadeh and Mokhtari, 2003).

2.5 Bam Earthquake

At 7:56GMT (5:26 a.m. local time) on December 26, 2003, an intense earthquake shook a large area of the Kerman province in Iran. According to International Institute of Earthquake Engineering and Seismology (IIEES) in Tehran and the strong ground motion recorded at a Bam station, a large vertical component with a maximum peak ground acceleration (PGA) of 1.01 g was observed at the region (Eshghi and Zare, 2003). The preliminary reports by USGS and IIEES estimated the earthquake magnitude to be 6.6 on the Richter scale with duration of 20 seconds and a maximum PGA of 0.98 g. (BHRC, 2003). The earthquake destroyed most of Bam city and the nearby villages and death toll exceeded 43,000 with more than 30,000 injuries and 75,000 left homeless.

The earthquake damage was concentrated in Bam where the total number of people directly affected was estimated to be approximately 200,000. Few buildings survived without major damage and one of the main losses in the earthquake was a major cultural heritage site and the world’s largest mud-brick structure, known locally as Arg-e Bam (Bam citadel), which suffered extensive damage. In addition to mud-brick buildings which suffered effects ranging from severe damage to total collapse, many other types of buildings such as steel structures and reinforce concrete structures also exhibited similar degrees of extensive damage. This can be attributed to the poor materials and construction that are common features of these structures. Some buildings, which their performances were accepted in the earthquake, had superior design and construction, among those were some steel structures with braced frame lateral load resisting systems.

The most dominant structural systems in the Bam region were:

• Adobe buildings: built from adobe materials and unfired mud bricks. Most of these building have a vaulted roof system.

• Masonry buildings: built from fired bricks or concrete block-work as the main load bearing system and normally combined with a jack-arch roof system.

• Steel structures: typical construction includes frame structures with steel beams and columns and sometimes a braced framing system to resist the lateral loads.

• Reinforced concrete structures: only a limited number of these structures existed in Bam and mostly used for public buildings or government offices.

Outside the city, in the villages and surrounding countryside, adobe and masonry buildings were the main structural types (Eshghi and Zare, 2003; Jackson et al., 2006).

3.0 Reconstruction Experiences

From 1978 to 2003 after the Tabass (1978), Ghaen (1980), Golbaf (1981 and 1989), Manjil (1990), Bojnoord (1997), North-western (1997), Ghaen-Birjand (1997), Western Iran (2002), and Bam (2003) earthquakes, the damaged cities and villages were reconstructed with different policies and engineering designs (Allamehzadeh and Mokhtari, 2003; Walker et al., 2003; and Eshghi and Zare, 2003). However, in the two cases of Golbaf and Ghaen-Birjand, the re-occurrence of earthquakes in March 1989 and May 1997 respectively, was a factual test and engineering appraisal of these reconstructions. The tests showed different responses. In case of Ghaen and Birjand, after the earthquake on May 1997, the majority of the ductile moment resisting concrete frame with masonry infill housing units and schools were totally destroyed due to magnitude 6.6 earthquake and created sorrowful scenes. Because Ghaen and Birjand are located in the desert land, due to protection the buildings against high temperature in summer and low temperature in winter, the wall and roof were built too thick and heavy for insulation purposes. Improper design (strong beam-weak column and heavy roof) as well as poor workmanship, lack of supervision and quality control, and absence of proper project management knowledge during the construction and re-construction caused the tragedy (Ghafory-

Ashtiany and Eslami, 1997; Akhavan, 1998; and Allamehzadeh and Mokhtari, 2003).

In some cases adobe and masonry buildings had less damage than the "so called" engineering buildings. In the case of Ghaen not only these buildings but steel and reinforce concrete structures that were supposed to be constructed according to the seismic code of Iran, were destroyed or slightly damaged. According to Ghafory-Ashtiyany (1999), in his research, the reconstruction of Ghaen after1980 earthquake was a failure and was the key reason of large number of casualties during the earthquake of 1997. People thought that they were living in earthquake proof housing with engineering design. Due to this poor performance, the people did not trust the engineering structures and thus they did not cooperate very well in reconstruction programs.

In the case of Golbaf (500km west of Ghaen) the experience was totally different. All of the rebuilt constructions after 1981 earthquake extant with minor damages in the March 1989 earthquake. The damages involved in adobe and masonry buildings and some exterior walls outside the living units. Regarding to the sound reconstruction in Golbaf, 3,000 deaths in 1981 were reduced to five people in 1989 earthquake, considering that the earthquake happened at night and most people were at homes. According to Ghafory-Ashtiany (1999) the design of reconstructed units in both cases of Golbaf and Ghaen was similar. The differences were due to skill workers, supervision and quality control, consciousness of people of building safer structures, and the utilization of project management knowledge (Amini Hosseini et al., 2004; Akhavan, 1998; and Ghafory-Ashtiany and Eslami, 1997).

4.0 Discussion

Like southern California, Iran sits on an active plate boundary that is characterized by strike-slip and reverse faults. Although Iran's faults have had little paleoseismic study, the country has a rich historical and archaeological record that spans several thousand years (Nowroozi, 1972; McKenzie, 1972; Jackson and McKenzie, 1984; and Ambraseys and Melville, 1982).

Earthquakes are not new in Iran, there have been several powerful earthquakes during twentieth century claiming more than 170,000 lives, and no doubt Iran will continue to be hit with powerful earthquakes in the future. Earthquakes are a fact that everyone in the country now fully appreciates. Memories of the Buien-Zahra, Dasht-e Bayaz, Tabas, Golbaf, Manjil-Rubar, Ghaen, and Bam earthquakes are unforgettable, not only for the people who survived these earthquakes but also the many others who have been touched by the news of the tragedy. However, despite this knowledge the fact remains that the country appears powerless in dealing with the earthquake issue with little sign of improved national statistics with regards to seismic fatalities and damage (see Table 1). Large death tolls and financial losses are still the main characteristics of Iranian earthquakes. It is interesting to note that on December 22, 2003, four days before the Bam earthquake, an earthquake with magnitude of 6.5 in Richter scale, similar magnitude to that of Bam earthquake, struck California and did not cause any dramatic damage or destruction with unimaginable death toll where only a handful of people were killed (McEntire and Cope, 2004; and CSSC, 2004). This clearly demonstrates that the knowledge to protect human life against earthquakes exists and the international community needs to focus on applying this knowledge to earthquake prone areas to minimize and mitigate the risks arising from major earthquakes.

Comparison of recent records on the impact of earthquake hazards of similar magnitude in countries of varying levels of development is astonishing. During the Ms=7.1 Loma Prieta, California earthquake of 1989.10.17, only 63 people were killed which is a very low casualty figure for an earthquake of such magnitude. Compare this with the 12,225 deaths during the 1962.09.01 (Ms=7.2) Buin-Zahra earthquake in Iran and 12,000-20,000 deaths in 1968 (Ms= 7.3) Dasht-e-Bayaz earthquake (Fujita, 2001). The difference in casualty numbers between these events is directly related to differences in disaster preparedness and disaster mitigation in the United States of America and Iran. Strict adherence to building codes during the past three decades in the San Francisco region undoubtedly saved many lives and kept thousands of buildings from collapsing in the Loma Prieta earthquake (McEntire and Cope, 2004); no similar step was seriously undertaken in Iran. In California, building codes and geologic site investigations were increasingly accepted; Iran has no comparable public commitment, and many houses are built with un-reinforced masonry in the small town and villages (Ghafory-Ashtiany and Eslami, 1997; Mehrabian et al. 2005; Akhavan, 2006). Despite the frequency of earthquakes in western United States, the number of deaths due to earthquakes has been very low in the past fifty years as compared with losses in Iranian earthquakes. In this century, earthquakes in North America alone have resulted in more than 1,000 deaths, while at least 170,000 people have lost their lives during earthquakes in Iran from 1950s. The research summarizes the statistics of the huge earthquakes from 1950 around the world in Table 2. The statistics show that most of the huge earthquakes around the world make a lot of casualties in developing and third world countries but less in developed countries such as the USA. Comparison of Table 1 and Table 2 shows nearly 25.5% of the deaths and fatalities of the earthquakes from 1950 around the world were in Iran. On the other hand, according to the last statistics (July 2007) the world population are 6,602,224,175 and Iran population is 70,049,262. This shows Iran has nearly 1.06% of the world population. Comparison the percentage of Iran's population and its fatalities on the past earthquakes in the world indicates that Iran by having nearly 1.06% of the world population allocated 25.5 % of the earthquake fatalities to itself. On the other hand it shows that the deaths and disasters of earthquakes in Iran are 25.5 times more than the theoretical expectation.

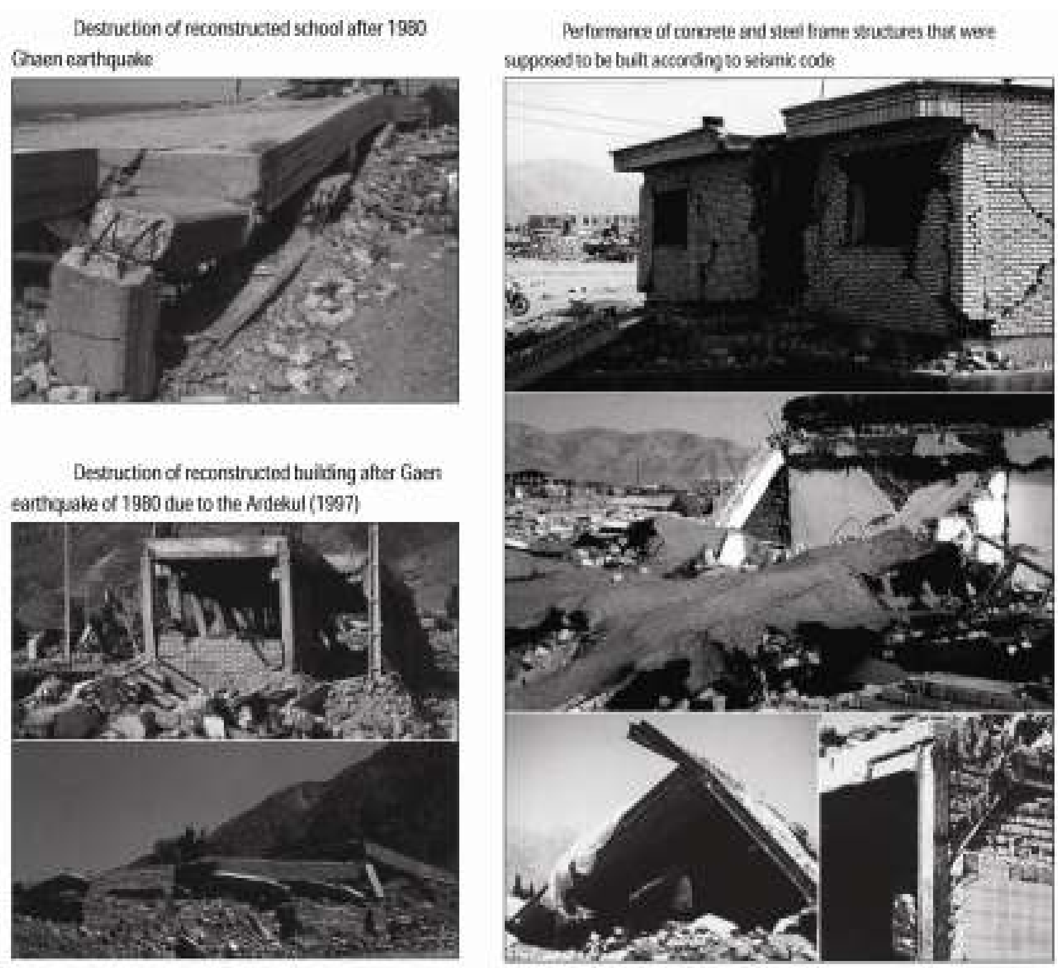


Plate 3.1 – Ghaen and Ardekul earthquakes (1980, 1997)

Source: Ghafory-Ashtiany, 1999

No.	DATE	Magnitude (Richter scale)	Location	No. of Dead
1.	1953	7.3	Turkey	1,070
2.	1954	6.8	Algeria	1,250
3.	1957	7.1	Mazandaran-Iran	2,000
4.	1957	7.1	Hamedan and Kermanshah- Iran	2,000
5.	1962	7.1	Buin-Zahra, Iran	12,225
6.	1966	7.0	China	1,000
7.	1966	6.8	Turkey	2,529
8.	1968	7.3	Dasht-e-Bayaz, Iran	12,000-20,000
9.	1970	7.5	China	10,000
10.	1970	6.9	Turkey	1,086
11.	1970	7.9	Peru	70,000
12.	1971	6.9	Turkey	1,000
13.	1971	6.6	California, USA	65
14.	1972	7.1	Southern Iran	5,054
15.	1974	6.8	China	20,000
16.	1975	7.0	China	2,000
17.	1975	7.2	Hawaii, USA	2
18.	1976	7.5	Guatemala	23,000
19.	1976	7.5	China	255,000
20.	1976	7.9	Philippines	8,000
21.	1977	7.2	Romania	1,500
22.	1978	7.8	Tabas, Iran	25,000
23.	1980	7.7	Algeria	5,000
24.	1981	6.9	Southern Iran	3,000
25.	1981	7.3	Southern Iran	1,500
26.	1983	6.9	Turkey	1,342
27.	1983	6.9	Idaho, USA	2
28.	1985	8.0	Mexico	9,500
29.	1987	7.0	Colombia	1,000
30.	1987	5.9	California, USA	8
31.	1987	5.6	California, USA	1
32.	1988	6.8	Armenia	25,000
33.	1989	6.9	California, USA	63
34.	1990	7.4	Western Iran	40,000-50,000
35.	1990	7.7	Philippines	1,621
36.	1991	7.0	North India	2,000
37.	1992	7.5	Indonesia	2,500
38.	1992	7.3	California, USA	3
39.	1993	6.0	Oregon, USA	2
40.	1994	6.7	California, USA	60
41.	1995	6.9	Kobe, Japan	5,502
42.	1997	7.3	Northern Iran	1,567
43.	1999	7.6	Turkey	17,118
44.	1999	7.6	Taiwan	2,400
45.	2001	7.6	India	20,085
46.	2002	6.1	Afghanistan	1,000
47.	2003	6.8	Algeria	2,226
48.	2003	6.6	California	2
49.	2003	6.6	Bam, Iran	31,000-43,000
50.	2005	8.6	Northern Sumatra, Indonesia	1,313
51.	2005	7.6	Pakistan	86,000
52.	2006	6.3	Indonesia	5,749
Total people approximately who killed during the huge earthquakes around the world from 1950s				**687,845**
Total people approximately who killed during earthquakes of Iran from 1950				**175,450**
Percentage of the Death Tolls of Iran Compare to the world				**25.5%**

Table- 2 – A brief history of huge earthquakes in the world from 1950s

Our mind might be occupied by the question of why many constructions were destroyed and caused lots of fatalities during the past earthquakes in Iran. According to the researchers, some of them are said to be due to inefficient design and lack of standard materials (Ghafory-Ashtiany and Eslami, 1997; Berberian and Yeats, 1999; Berberian et al., 1999; and Allamehzadeh and Mokhtari), while many of the buildings with standard materials and proper design were destroyed during the earthquakes for low quality construction (Berberian and Yeats, 2001; Berberian et al., 2001; Berberian, 2004; Mehrabian et al. 2005; Mehrabian and Haldar, 2005;) and lack of utilization of project management knowledge (Akhavan, 2006).

Some important lessons about earthquakes and management in Californian from Johnson research on 2004 are as follows:

-A large earthquake in or near a major urban centre in California will disrupt the economy of the entire state and much of the nation. Effective disaster planning by state and local agencies, and by private businesses, can dramatically reduce losses and speed recovery.

-Current building codes substantially reduce the costs of damage from earthquakes, but the codes are intended only to prevent widespread loss of life by keeping the building from collapsing, not to protect the building from damage.

-After a large earthquake, residents and businesses may be isolated from basic police, fire, and emergency support for a period ranging from several hours to a few days. Citizens must be prepared to survive safely on their own, and to aid others, until outside help arrives.

-Maps of the shaking intensity after the next major earthquake will be available within minutes on the Internet. The maps will guide emergency crews to the most damaged regions and will help the public identify the areas most seriously affected.

Comparing California's damages to construction after the past earthquakes with disasters of earthquakes of Iran in same magnitude is astonishing. Plate 2 shows the differences between the buildings structural damages in California and Bam earthquakes in 2003 with the same magnitude. Efforts to reduce the losses from earthquakes have already proven effective in California. California's enhanced building codes; strengthened highway structures; higher standards for school and university, police and fire station construction; and well prepared emergency management and response agencies, reduced deaths, injuries and damage in recent earthquakes (McEntire and Cope, 2004). Unfortunately, in the case of Bam earthquake 2003, the buildings which must built in higher standards and be survived after any occurrence such as hospitals, police and fire stations, highways and schools were destroyed and out of served.

In other words, it is well known that the building construction practice in Iran and more specifically in small cities like Bam has been poorly regulated and monitored. There is clear evidence of this from the Bam Earthquake. Widespread damage to the majority of newly constructed buildings in the both public and private sectors were observed by the researchers (Amini Hosseini, 2004; and Mehrabian and Haldar, 2005). This strongly suggests that poor construction practice and lack of effective project management played major roles in the vast destruction and high death toll and sorrowful tragedies within the city.

5.0 Recommendation

For more than forty years, editorials have been written, speeches delivered, reports and books published, funds granted, rules, regulations and laws promulgated on the subject of earthquakes and their risks, and foreign helps were funnelled into the country after occurrences of large-magnitude earthquakes in Iran. Despite these, we still cannot minimize the death tolls and financial losses of earthquakes in Iran.

In the case of Ghaen-Birjand and Bam earthquakes many buildings which were constructed during the last decade totally collapsed. The majority of these buildings were in private sector. On the other hand some of the public buildings, especially government offices destroyed, since those were obviously benefited from better design and materials. Mostly lack of project management practices utilization in construction projects in the most parts of Iran made the tragedies. Some recommendations can be made by the study are as follows:

1. Seismic design code: The current Iranian seismic code is published in three chapters and six appendices. The first chapter defines the general applicability criteria, classification of the structures in terms of their importance, form and structural system and also gives general design recommendations. Chapter two sets down rules for calculation of seismic loads and apply to all types of building structures except un-reinforced masonry which is covered in chapter 3. The code intent is to provide a level of seismic resistance for buildings such that they can resist low and medium earthquakes without any considerable damage to their structural system and withstand strong earthquakes without collapse. The design earthquake is defined as the one with less than 10% probability of

occurrence in a 50 year period. For structures with high importance or those higher than 50m or having more than 15 stories a serviceability level earthquake also needs to be considered. This is defined as one with more than a 99.5% probability of occurrence in a 50 year period (SDCB, 2002).

The implementation of the code is a major issue and there are several areas that need to be addressed. Firstly, proper and effective training has not been provided for many professionals who are generally only familiar with general building design and preparation of drawings without any seismic design considerations. Secondly, there are only limited official guidelines that accompany the code and clarify the use of code provisions for practicing engineers. It appears that providing background information and examples of the code provisions could greatly improve the successful implementation of the code. Thirdly the lack of construction control leads to poor construction and poor performance under earthquake loading.

2. Absence human resource management practices: Most of the people who are working in the construction industry are unskilled and unlicensed. This results in poor material production and construction. A process should be implemented to train and licence professional working in construction. Lack of HRM practices in the construction industry and low quality of construction was shown by the previous study with the authors. Regarding the previous study of Akhavan (2006), one of the important problems which most of the construction projects in Mashhad faced was the lack of expert workforces. Mashhad is the second city of Iran in terms of population, area and construction projects; also being located in the territory with high risk of earthquake. Accordingly, nearly 20% of the workers in Mashhad construction projects were skilled labour with technical certification of fitness of occupation. The result of the study can be developed to other parts of Iran too. Some profitable methods which can be utilized by government to educate construction labour are presented as follows:

-Short term training courses at a fixed centre

-Send trainers to the construction sites (on-the-job training)

- Self learning and taking part in the standard exam

On the other hand some rules and regulations in order to support labour and improving their state of affairs should be legislated by the government. Some of the endeavors which can be applied by the government are as follows:

-Increasing the social security

-Pay towards of their costs of living

-Forcing the companies to use the labour with certification of fitness of occupation

-Social insurance

3. Lack of construction control: For many projects, especially for private housing, the design or civil engineers have the responsibility of supervising and approving the construction. However, there is no effective control in this process and often the engineer only takes the role of approving the design drawings (Mehrabian and Haldar, 2005). In other words, lack of project managers and project management practices can be observed in most of construction projects of Iran. An effort should be made to increase the awareness among the authorities with respect to legal and professional responsibilities in order to project management knowledge and to include strict control of construction practices.

4. Lack of quality management: Most of the constructions were destroyed in the past earthquakes did not have appropriate quality of construction, this is declared by several researchers such as Ghafory-Ashtiany and Eslami (1997), Ghafory-Ashtiany (1999), Mehrabian et al. (2005), and Akhavan (1998). Also, it confirms the lack of effective project management practices and utilization in the construction projects in Iran. Importance and significance of project management knowledge should be developed among the construction projects by the government. According to McEntire and Cope (2004), after the California earthquake in 1974, government by utilizing and exploiting effective project management knowledge and practices prevent and reduced the fatalities and economic losses in future. In order to reduce fatalities, property losses, and increase the quality of construction in Iran the government can set out to establish an organization with professional project mangers. The organization should develop and put in order the project management knowledge and practices, for the purpose of increasing the quality of construction and making cities and towns safe at all level of construction projects.

On the other hand, to achieve a seismic structure after reconstruction of a damaged area, the following principles should be considered and adhered to by the Housing Foundation or Ministry of Housing and Urban Development (MHUD) as responsible organizations in the reconstruction of the damaged area:

(1) Site selection. To designate a suitable site for reconstruction in the destructed and damaged area, the following aspects should be taken into consideration:

- Local geology
- Seismotectonic

- Geotectonic
- Site effect
- Socio-economic and
- Cultural aspects

(2) A seismic design and construction. All new structures should be designed against earthquake with the seismic cods. In this regard, MHUD should design following types of dwelling for reconstruction purpose:

- Concrete frame with arch roof to be used in the hot climate
- Concrete frame with flat jack-arch roof to be used mainly in the cold climate
- Steel frame with flat jack-arch roof to be used in any environment
- Steel frame with composite roof (steel beam and reinforce concrete slab) to be used in any environment
- Concrete frame with composite roof (steel beam and reinforce concrete slab) to be used in any environment
- Concrete frame with sloped timber roof
- Timber frame to be used in most of the small towns and villages

Also construction should be done by qualified construction companies which can be defined by the MHUD.

(3) Construction material. The quality and environmental availability of the construction material is an important element in an earthquake resistant structure. In most cases of the past earthquakes the damaged areas were remoteness and faced to low accessibility to the skilled workers as well as appropriate machinery and equipments, high quality and available construction material should be used in order to assure a safe construction. For example, if good quality concrete material (sand, gravel, water, and cement) cannot be procured locally or is expensive in the environs of the damaged area, the use of a concrete frame structure should be avoided and the structure should be designed using steel or prefabricated elements. There should not be any restriction on choosing the most suitable material.

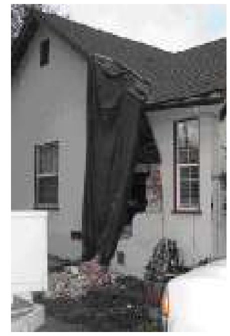
(4) Strengthening of older buildings. The Government should provide criteria and typical details for the strengthening of older buildings in various parts of Iran.

(5) Quality control, supervision, and project management. Quality control, supervision and managing the projects of all the above mentioned principals are the key element to successful reconstruction.

The cities and towns can be made safely by developing the knowledge of project management and its practices in managing resources at all level of constructions. Consequently, the fatalities and economic losses due to unpredictable events like earthquakes will be reduced.

Minor damage at column connection to Twin Cities Hospital in Templeton, California, 2003 (Source: RMS 2003)

Damage to brick façade of the Atascadero City Hal after California earthquake, 2003 (Source: RMS 2003)



Chimney damage to residential buildings after California Earthquake 2003 (Source: RMS 2003)

Destruction and out of servicing of fire station after Bam earthquake, 2003

Destruction and of Ferdowsi high school building after Bam earthquake, 2003

Destruction and out of servicing of Hospital after Bam earthquake, 2003

Plate 2- Comparison of California and Bam buildings destruction in the earthquakes 2003

6.0 Conclusion

Despite the history of tragic earthquakes, and their continuing recurrence in Iran, and the fact that the knowledge exists to deal effectively with the threat posed it appears that the issue of seismic risk has not to date been addressed particularly effectively. This failing runs through every level of society at individual and company levels and is reflected by local authorities, and central government. It is reasonable to ask why the obvious lessons of the earthquakes are being ignored. Perhaps the intermittent nature of devastating earthquakes tends to create a culture of acceptance of the status quo and failure to take responsibility in a society which has mainly focused on short term needs. It is obvious, that for any plan to work successfully this culture needs to change and the requirements for fundamental earthquake hazard reduction need to enter national consciousness at all levels of society and then be enforced with minimum tolerance of negligence. Also, the study aims to make the government, companies, and managers of disasters aware of the aftermath in different parts of Iran of low quality construction, lack of utilization of project management knowledge, and make a consciousness for applying proper ways to prevent probable damages.

7.0 Limitations and Future Research

The current study has some limitations that offer an agenda for future research. As the research has been confined to compare fatalities and economic losses during the past earthquakes between Iran and other countries, especially USA, a large-scale follow-up survey would be useful to find out which of the identified differences have the proposed connection in order to reduce the number of fatalities and economic damages. We found a range of methods and recommendations in construction and reconstruction practices that play a role, but which methods are most relevant for each parts of Iran is not yet clear. It seems unlikely that all practices can be treated as atomistic ingredients that have an additive enhancing effect on idea generation and/or application on quality of construction.

Thus, future research should also try to address how companies, managers, and governments adapt to and even shape the environmental and organisational settings in such a way that the context optimally stimulates project management knowledge and practices effects on increasing the quality of construction.

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