

## LESSONS LEARNT FROM SHELTER ACTIONS AND RECONSTRUCTION OF BAM AFTER THE DESTRUCTIVE EARTHQUAKE OF DECEMBER 26, 2003

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### ABSTRACT:

In this paper, the issues of temporary shelters and reconstruction are considered from three points of view: 1) Government involvement, 2) Community contribution, and 3) International community participation. The role of management in coordination of activities of all sectors contributing in temporary actions as well as reconstruction activities is thoroughly investigated and its weakness and strengths are discussed. The development of temporary and permanent shelters is addressed in various aspects. The first is the technical aspect to find out how appropriate the shelters have been reconstructed to resist the future earthquakes. The second aspect deals with the social and cultural characteristics of the city and its people, and the degree that the architectural features could match the local culture in the recovered area. Issues such as adaptability of people with the new situation and their resilience are also discussed. The last aspect is with regard to economical issues and how they have influenced the livelihoods of affected people. At the end, based on the lessons learnt, some recommendations are made which are believed to be useful for preparing the plans for the shelter actions as well as the reconstruction process for future similar cases.

**KEYWORDS:** Shelter Actions, City Destruction, Reconstruction, Bam, Architectural Features

### 1. INTRODUCTION

The whole destruction of a city in an earthquake which requires a complete reconstruction has not been a frequent case in past earthquakes in the world in recent decades. However, Iran has the sad experience of almost complete destruction of four cities in its recent history. These include Tabas city, destroyed by an earthquake in 1978, Manjil and Rudbar cities, destroyed in 1990, and finally Bam, which was mostly reduced to rubble in 2003. The low seismic resistance of old buildings in Iranian cities, which are mostly masonry and non-engineered buildings and consist the major category of residential and even commercial and office buildings, makes it possible to have cases similar to Bam in future in some other parts of the country. The shelter actions and reconstruction of Bam has had several features, which make it different from other past cases. Therefore, the lessons learnt from this study can be very useful for the similar future cases which are likely to happen in Iran and similar earthquakes prone countries.

The reconstruction following the Manjil-Rudbar earthquake of 1990 was the starting point for serious "earthquake risk reduction" in Iran. This was the first major national experience of 'safe recovery' following a major disaster (aside from the limited experience gained in reconstruction of Tabas after the destructive earthquake of 1978). Since that time many earthquakes have occurred and various experiences have been obtained, especially in the area of rural reconstruction. Most of these experiences have been documented by Housing Foundation of the Islamic Republic of Iran (IRHF 2007), however, they have not publicized internationally to help other countries make benefit of these experiences. In this paper, the issues of temporary shelters and reconstruction are considered from various points of view. The role of management in coordination of activities of all sectors contributing in temporary actions as well as reconstruction activities is thoroughly

investigated, and finally, based on the lessons learnt, some recommendations are made which are believed to be useful for preparing the plans for the shelter actions as well as the reconstruction process for future similar cases in Iran and other developing countries.

## 2. LINKS BETWEEN SHELTER ACTIONS AND RISK MAPPING AND MANAGEMENT

No risk management action has taken place in Bam or any other city in Iran, before the Bam earthquake. Therefore, the shelter policy and practice was not influenced by any risk management or risk mapping process. After the Bam earthquake, a microzonation study was carried out in Bam by the International Institute of Earthquake Engineering and Seismology (IIEES), for the seismic hazard (Askari et al 2004). As the 'Master Plan' of the city had been prepared almost completely before the earthquake by Armanshahr Consulting Engineers, the 'microzonation map' was delivered to them to be used in land-use decision making and this was partially used to modify the city master plan. This revision did not cause any delay in reconstruction process, as the debris removal was a major problem and created an opportunity to revise the master plan. The bylaws, developed after the earthquake, were limited in scope and microzonation considerations were observed in reconstructing the important components of the city. However, aside from the seismic threat no other hazard has been studied in detail so far to support safe reconstruction of the city and its surrounding areas.

The aftershocks did not have a significant affect on shelter policies and provision after the disaster. People were reluctant to live in masonry houses, because of the pressure they had experienced in the disaster and the high likelihood of being killed in such buildings. Other hazards also were not taken into consideration, however, the temporary shelters were mostly strong enough for the aftershocks and the fire safety was considered to some extent in their initial design. The lack of pre-disaster hazard mapping resulted in an absence of vulnerability assessments and consequent action could have taken place before the event. However, after the earthquake around 2000 damaged buildings, mostly houses were inspected for their probable remaining resistance against future earthquake(s) by some consulting firms, and most of them were designated as being repairable and were strengthened to an acceptable extent. Many of the temporary shelters were strong to resist aftershocks (Figure 1).



Courtesy: Pir-Ata



Figure 1 Temporary shelters with high integrity

Figure 2 The wrong installation of shelter

In fact, the temporary shelters with high structural integrity could appropriately withstand aftershocks despite being set on loose stone footings, however, in many cases, lack of knowledge and supervision caused some inappropriate installation which could have been vulnerable if a major aftershock would have happened (Figure 2). In such cases the wrong installation of the shelter on rudimentary brick pedestals had placed the shelter at risk from aftershocks.

## 3. SHELTER ACTIONS IN BAM

The issues of temporary shelters and reconstruction are considered from three points of view in this paper:

1) Government involvement, 2) Community contribution, and 3) International community participation. These three are discussed separately in the following sections.

### ***3.1. Government Involvement***

The shelter actions can be divided into three main parts of emergency shelters, temporary shelters, and permanent shelters (or dwellings). The Government of Iran played a major role in regard to each of these parts. Emergency shelter actions were carried out by the Ministry of Interior and The Red Crescent Society of Iran. Also, several national and international Non-Governmental Organizations (NGOs), attended the area within a few days after the event. During the first hours following the earthquake, the Rescue and Relief (R&R) teams from various provinces were randomly distributed throughout the city and this resulted in repeated service to some stricken people and no service at all to some others who were in acute need. However, after a few days, the 1<sup>st</sup> Vice President (VP) of the country visited Bam and divided the city into sections and assigned the R&R team of each province to each division, so that these teams in any province could concentrate on only one part and provide its services more efficiently and appropriately.

After the earthquake and accomplishment of the emergency response, same coordination took place for the temporary shelter actions which continued for around one year. In the third stage, the reconstruction committee was established, which has included the President with 9 other members from various related ministries. Up to 2007, (almost four years after the earthquake) 40 meetings have been held and it has developed 56 bylaws which have been to be enforced and implemented. The technical committee was assigned the tasks for all other members as follows (Interview with Mr. Bazzazan 2007):

- The Housing Foundation was responsible for building houses in villages, the mosques, the business centers as well as undertaking studies on the comprehensive master plans of villages;
- The executive body was located in headquarters for reconstruction and the governmental and public facilities and the governmental buildings;
- The Ministry of Energy was responsible for water and electrical power (water, electrical power and the underground cables were reconstructed);
- The Ministry of Telecommunications was responsible for the telephone and mobile systems;
- The Islamic Republic of Iran Broadcasting was responsible for the audio and visual effects;
- The Ministry of Industry was responsible for industrial section with the help of the Industry and Mine Bank;
- The State Organization of School Renovation was responsible for the reconstruction of the schools;
- The Ministry of Transportation was responsible for reconstructing the routes (Mahan to Bam) using the Bam reconstruction funds.

Another important contribution of the Government was to provide financial aid for very low income (or 'no-income' people) as well as providing low interest loans for low income people in Bam. These aid and loan programs enabled people to pay for the costs of rebuilding their houses and shops and restore their livestock. The amounts of these aids and loans have been as follows (IRHF 2007):

- 3.5 million Tomans (925 Tomans is almost equal to 1 \$USD) plus 1 million Tomans for the yard wall construction in the city and 1.5 million Tomans in villages were given as aid.
- 10 million Tomans in the city and 6 million Tomans in villages have been given plus 1 million Tomans for yard wall construction as low-interest (5%) loans, which make the total financial support up to 15.5 million Tomans in the city and 9.5 million Tomans in villages.

In reconstructing the damaged residential and commercial units in the city and villages, the following issues were among the main concerns of the Government (Ghafory-Ashtiani and Hosseini 2007):

- Promoting regional construction quality and making maximum benefits of the local expertise in order to create job opportunities and promote their technical know-how;
- Establishing the construction market (Bazaar) with the objective of providing the required consulting, technical and engineering services through certified consulting companies; as well as construction materials, markets and stores;
- Preparing the ground for mass-constructors to build residential complexes in areas where the construction of residential units required specialist attention;

- Setting up the Bam Architecture Council to issue orders on architectural designs and urban development in conformity with Islamic cultural, social, and regional values of Bam;
- Running laboratories to control the quality of construction materials;
- Adopting an effective construction quality control.

However, some of goals could not be achieved because of time limitations.

Finally, the timing of the shelter actions and reconstruction process was (Interview with Mr. Bazzazan 2007):

- Based on the government's plan the reconstruction started in April 2004 and was scheduled to be finished by October 2007.
- Around 30,000 rural, 30,000 urban and 5000 business units were built up to October 2007.
- Purchasing lands were delayed because of the lack of information with regard to land ownership in many cases.
- In the third year that the reconstruction was delayed, the people had to pay 30% of the rise prices themselves.
- Around 1800 units were rebuilt and were allocated to tenants.
- Before the earthquake, there were 138 schools in Bam, while as a result of repairs and reconstruction the number increased to 181 schools (only 30 of the damaged schools were repairable).
- Retrofitting of parks has been done and is almost completed.
- The number of residential units before the Bam earthquake was 22,000, while after the disaster this number went to 31,000 despite the very high casualties experienced in the earthquake. (In February 2004, the government estimated death toll was 26,271).
- The construction of water pipes and underground cables is still under continuation as for September 2007.

### ***3.2. Community Participation***

As noted above, loans were provided for the reconstruction which made the whole recovery process easier for the people. People themselves were responsible for the reconstruction of their houses and shops with the government only providing them with necessary facilities. One very important factor that facilitated the community participation was the presence of a 'construction market' which was developed in Bam just a few months after the event (Havaii and Hosseini 2004). People could contact the municipality for the 'site plan' maps. The Kerman Engineering Organization (under the Ministry of Housing and Urban Development) was responsible for checking and confirming the technical drawings (free of charge as another aspect of the Government participation). After the confirmation of technical drawings, the owner could get permission for construction from the Municipality (which was issued free of charge, again as a part of the Government participation), and after this, the owner could sign a contract with the construction companies in the city.

Another aspect of the community participation was the presence of several small construction companies in the affected area, drawn from all over Iran (most of the large construction companies are semi-governmental). As a result, the surviving community could become active in the reconstruction process. Through this, other small communities, particularly those composed of working class people, were able to play an effective role in rebuilding their homes.

In spite of appropriate community participation it should be noted that at the first few months people were more sensitive to the resistance of their new buildings against future earthquakes, but after a while, due to the administrative problems and lack of sufficient and available technology, they had no choice other than to agree that the reconstruction situation would not get any better. Therefore, they restarted the use of masonry construction once again and used the old welding techniques in their construction. Therefore, quality control became very weak at that point. However, there were also some good reconstruction works as using bolt connections (Figure 3).

Unfortunately, this good practice was abandoned after some months due to the lack of skilled workers who could make the bolt connections, or due to the lack of proper materials. People also made the containers, provided as temporary shelters, a part of their houses within the walls around them, as can be seen in (Figure 4). It can be seen in this figure that with construction of a wall around the container, it has been accepted as a permanent part of the house. Also the low quality of masonry work of the wall is notable in (Figure 4).





Courtesy: Pir-Ata



Figure 3 Use of bolt connections in steel frames

Figure 4 Using a container as a part of the house

Another technical shortcoming with regard to community participation was connecting the steel stairs to the brick wall which results in a very low quality of work as shown in (Figure 5). The use of castellated beams as main girder was another weak point shown in (Figure 6), in spite of the fact that this is not allowed by the National Iranian Construction Code for steel structures.



Courtesy: Pir-Ata



Figure 5 Connection of steel stairs to brick wall

Figure 6 Use of castellated beams as main girders

Based on the observation, parts of the reconstruction work undertaken by the government was of high quality, but those parts that were implemented by people themselves were built to an inferior standard. It should also be mentioned that although the authorities and even the local people would like to preserve the character of the city, their main priority for the residents was the safety of buildings. However, there were an obvious conflict between being aware of the need for seismic safety in buildings, and the financial burden of the materials specified (Mobasser 2006).

An Iranian people-empowerment NGO called “Hamyaran” carried out projects in Baravat through community consultation. As stated in Mobasser (2006), “the main objective of this organisation was to establish a livelihoods empowerment programme in order to increase the economic capacity of the local community of Baravat”. Hamyaran believe that there has been very little commitment to the reconstruction of public buildings devoted to economic development. Housing has been the priority of the reconstruction programme with no effort applied to bazaars in the area, a sector that contributed to a large proportion of economic activity. This has resulted in a drastic increase in unemployment rates. Their observations reveal that families have been forced to live in various locations for the sake of their children’s education. Most schools have been located on camp sites on the outskirts of the Bam city, however most of the people prefer to live on their own land which resulted in a trend of young families migrating from the area permanently (Hamyaran 2005).

### 3.3. International Community Participation

The R&R teams from other countries were around in the first days after the event with little coordination,

but after the VP's attendance in the area, some officials were assigned as a contact source to coordinate the activities.

Foreign aid was in total around 10,000,000 USD (mostly paid through Iranian embassies), though none of the big promises of the foreign aid materialized (Bazzazan 2007). A 220 million USD loan was approved by the World Bank (ReliefWeb) and also one million USD aid has been provided by the Islamic Development Bank which has been spent for the disables in Bam by the welfare organization (Bazzazan 2007).

International organizations had also a contribution in reconstruction. In general, the UN strategy included three distinct but inter-related elements:

- 1) In short term, specific and targeted technical support to the start-up phase of the reconstruction and recovery program (Feb. May 2004),
- 2) Sustained technical and coordination support to the Government for the duration of reconstruction program to help ensure efficient and sustainable recovery and long-term disaster risk reduction (May 2004- Dec. 2005),
- 3) Capacity building for mainstreaming disaster risk reduction into development processes at local, provincial and national levels (2004-2009), (Kishore et al 2004).

As an example, the United Nations Development Programme (UNDP) contributed to the Bam reconstruction programme by setting up workshops aimed at preparing the model design in consultation with beneficiaries, as well as to provide technical consultation on urban planning and reconstruction programmes. The main objective of the organisation was to extend knowledge of, and promote expert views on post-disaster development. UNDP constructed about 130 modular model houses whilst training 400 local builders, as part of its rehabilitation programme. Dr. Kianpur, the UNDP Programme Officer for Bam, stated the design criteria for the houses as:

- To provide options for users;
- To allow for personal expression;
- To create locally familiar design;
- To have environmentally appropriate design;
- To be cost effective;
- To utilize appropriate technologies;
- To incorporate locally available materials;
- To encourage environmental friendly solutions.

However, it was mentioned that as a whole, none of the above criteria have been fulfilled in the Bam reconstruction programme. She believes the residents are not genuinely provided with options despite there being exhibition showrooms of houses and in addition all the designs are predetermined according to the simplest and most profit-making option (Mobasser 2006).

#### **4. KEY LESSONS CONCERNING SHELTER ACTIONS AND RECONSTRUCTION WORKS IN BAM**

Several key lessons emerge from the Bam earthquake in relation to shelter needs and provision, which can be divided into two positive and negative aspects. The positive aspects are:

- 1) The idea of convening a "construction market" worked better than building modular complexes and giving them to homeless people. The liberty in choosing the type of materials and the architectural design was also much better for the beneficiaries.
- 2) Reconstruction of "garden houses" by people themselves was a successful example of public participation in the reconstruction process.
- 3) Giving low interest loans was a useful mechanism that decreased the financial burden on the people. These loans were dispensed after the approval of construction drawings and inspection of each construction site.
- 4) Holding training sessions for people who intended to build their own houses proved to be an effective form of community participation in the reconstruction process.

Also the negative aspects are:

- 1) Temporary shelters delayed the reconstruction of the permanent housing. The main reason was due to people

- getting used to the temporary shelters, considering them as their permanent dwellings.
- 2) Taking shelter in emergency tent camps and in temporary shelter complexes was not welcomed by a majority of the surviving community. They preferred to stay in temporary tents in their own land despite the fact that their homes were totally destroyed.
  - 3) Insufficient building expertise in the city and its neighborhood caused some shortcomings in the quality of the construction. This gap was most serious in rural areas.
  - 4) Shortage of suitable materials (cement, aggregates, and steel profiles) in the city and its surrounding areas caused some delay in reconstruction work.
  - 5) People's indifference, especially amongst those who have had lost most or all of their family members and close relatives, and whose rebuilding of their houses was one of the main causes of the delay in reconstruction.
  - 6) The engineering offices were far from the city center and most of the residents. The primary concern was the location of the reconstruction bureaus in the "Construction Market" on the outskirts of the city, directly off the Bam to Kerman motorway. However, every Bam resident needed to visit the market at some point, quite regularly in many cases, and since the site was inaccessible without a car and other form of public transport, difficulties were created for the people, particularly in the first months after the earthquake.

In addition, there were some more recognizable problems in the Bam reconstruction process, mainly due to the lack of pre-planned reconstruction works (Hosseini 2007), such as the following concerns:

- Over-hasty decision making by the authorities resulted in illogical and over-optimistic promises being made to the survivors;
- Inability to effectively manage the financial resources which poured into the region shortly after the event;
- The decline in the nation's concern in comparison to the outpouring of emotion in the immediate aftermath of the disaster. Thus the critical situation of the region was rapidly forgotten. This 'fall-off' of concern occurred just when the people needed more financial and emotional support. In many ways this was more necessary in later stages of the recovery process than in the early days after the disaster;
- Poor management capability and coordination of the various organizations involved in the reconstruction programs. For example, various companies worked simultaneously in the reconstruction process of Bam and their lack of coordination and overlapping roles and activities at the time of crisis produced an impossible management situation.

There are also detailed issues to note with regard to temporary shelters, mostly from architectural design point of view, as follows:

- Inadequate, poorly designed yards adjacent to shelters (limited space for parking, limited space for a children's play areas, limited shared space, etc.);
- Undesirable impacts on the city as a result of temporary shelters evolving over time into permanent elements due to the lack of sufficient incentives to locate and collect them. (Also, this problem could be resolved in the next earthquake which might recur in the identical location and swiftly demolish the sub-standard structures.);
- The danger of accepting the conditions of the temporary settlements in permanent dwellings, resulting in a decrease in standards thus adversely affecting the quality of life;
- Delays created in the reconstruction process due to improper initial site selection;
- Not trusting the use of masonry in reconstructed buildings for emotional reasons in an attempt to reduce the stress;
- Converting part of the temporary camps to become an attractive site for Afghan immigrants and providing a settling for those people who did not have dwellings before the disaster as well as establishing new neighborhoods. This situation has the potential to create many security problems;
- A decrease in the observation of building codes, regulations and standards with the elapse of time after the earthquake, see (Figure 7). Buildings built earlier were constructed in a more appropriate manner according to the engineering regulations. This was seen in Lorestan 2006 earthquake as well (Izadkhah and Hosseini 2006).

However, despite many problems the surviving communities adapted themselves to the new situation very easily and after a while, things returned to almost normal.



Figure 7 Two columns positioned very close together indicate inappropriate structural design

## 5. CONCLUSIONS

Establishing the “Construction Bazaar” was an innovative way to make expertise widely available to the community who needed such knowledge. This benefited from the contribution of local people as well as being a key element in the enforcement of the quality control system for the reconstruction process. While the overall assessment indicates that concept of the “Construction Bazaar” was good, it still requires further adjustment for the future cases, especially to ensure the sustainability of the companies’ commitment to provide quality service to the people. Furthermore, it should be noted that in spite of the government’s priority attention to the reconstruction of Bam, and employment of some innovative ideas such as “Construction Bazaar”, there has been an inevitable delay in the reconstruction process, mainly due to the lack of “in-advance reconstruction plan”. Therefore, preparing the reconstruction plans for cities, particularly the old cities located in highly seismic zones is a very crucial issue for the sustainable development of the country. Finally, more attention should be given to social reconstruction and rehabilitation instead of focusing purely on physical reconstruction. The lessons also highlight the need to respond to people’s expectations and demands for rapid reconstruction, for larger amounts of loans, to cut ‘red-tape’ in providing construction permits; to facilitate rapid economic recovery and provide jobs for unemployed youths, etc. These concerns remain a major challenge and complete recovery is almost impossible, especially from the social and psychological aspects associated with such extensive losses. But there is no doubt that as a result of these efforts Bam will be a safer place to live.

## REFERENCES

- Askari, F., et al. (2004). Preliminary seismic microzonation of Bam, *Journal of Seismology and Earthquake Engineering (JSEE)*, Special Issue on Bam,
- Bazzazan (General Secretariat of Bam Reconstruction Headquarter), Personal Interview, November 2007.
- Ghafory-Ashtiany, M. and Hosseini, M., (2007). Post Bam recovery and reconstruction, *International Journal of Natural Hazards*, Published Online: 6 April 2007.
- Hamyaran NGO., (2005) Evaluation of public, civil society & private sectors reconstruction & rehabilitation activities in Bam.
- Havaii, M. and Hosseini, M. (2004). Bam earthquake from emergency response to reconstruction, *Journal of Seismology and Earthquake Engineering (JSEE)*, Special Issue on Bam Earthquake,
- Hosseini, M., Reconstruction of towns and cities after destructive earthquakes: challenges and possibilities from the urban design point of view, *Proceedings of the 9CCEE, Ottawa, Canada*, June 2007.
- IRHF, The collection of work progress reports of the Islamic Republic [Revolution] Housing Foundation (2007).
- Izadkhah, Y.O. and Hosseini, M. (2006). “Community challenges following Darb-e-Astaneh (Silakhore), Iran earthquake of March 31, 2006”, *9CCEE, Canada* 2007.
- Kishore, K., Komar Jha, S., Bagha, Z., Lyons, F., Ashtiany, M., Kianpour, V. (2004). A United Nations strategy for support to the government of the Islamic Republic of Iran following the Bam Earthquake of 26 December 2003. *Journal of Seismology and Earthquake Engineering (JSEE)*, 217-227.
- Mobasser, M., (2006). Factors impeding success in post-disaster housing with specific reference to Bam, Iran, Master Thesis, Oxford Brookes University, UK.
- ReliefWeb. (2004). <http://www.reliefweb.int/rw/rwb.nsf/db900sid/KHII-67E2ZT?OpenDocument>.