

Earthquake Recovery Experiences: Some Principles toward Sustainability

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SUMMARY:

This paper is about earthquake recovery studies in Iran based on Manjil Earthquake (1990) and Bam Earthquake (2003). Considering the Country's seismicity and the impacts and consequences of earthquakes, a study was carried out on earthquake recovery experiences based on two events in Iran to develop some guidelines toward risk reduction. The goal of the study was finding main highlights in recovering from earthquakes in both case studies to issue principles toward sustainable earthquake recovery. The main topic of the study was housing reconstruction and recovery in emergency, temporary and permanent phases in post-quake. The conclusions include evaluating the housing reconstruction trend in case studies, physical and social aspects of housing reconstruction, housing reconstruction and damage reduction, earthquake recovery through sound housing reconstruction and guidelines for sustainable earthquake recovery. This paper is helpful for earthquake recovery planners and the experiences are useful in similar situations in other countries as well.

Keywords: Housing reconstruction, Earthquake recovery, Manjil, Bam, Iran.

1. INTRODUCTION

In this paper earthquake recovery with emphasize on housing reconstruction in two experiences in Iran including Manjil Earthquake (1990) and Bam Earthquake (2003) is discussed. These experiences can be helpful in improving earthquake preparedness and response plans at national and local levels. The goal of the study was finding main highlights in recovering from earthquakes in both case studies to issue principles toward sustainable earthquake recovery. Based on the study goal, these objectives were considered:

1. How emergency and temporary housing policies and actions affected housing reconstruction;
2. How vulnerability reduction and risk management were considered in the housing reconstruction;
3. How housing reconstruction affected the recovery process.

The method of the paper includes four sections as follows:

First, the importance of housing reconstruction in post-quake and disaster recovery, effective elements in accelerating housing reconstruction and recovery. This section's information is based on the sources about reconstruction and recovery.

Second, overview of case studies, introducing the affected areas, earthquake characteristics and damages, emergency and temporary housing provision and policies, housing reconstruction policies and earthquake recovery. This section's information is based on national statistics, published reports, official documents and field visits in Manjil earthquake affected areas and Bam City.

Third, case studies discussion and comparison, based on previous section's information the two case studies are discussed and compared. The case studies' comparison distinguishes their similarities and differences. The case studies distinctions lead us toward recognizing potential areas for capacity building that is a step toward vulnerability reduction.

Fourth, according to the previous sections, conclusions are made and some guidelines for sustainable housing recovery are presented.

2. HOUSING RECONSTRUCTION IN POST-QUAKE AND DISASTER RECOVERY

Shelter and housing are among the immediate needs of the residents in earthquake stricken areas. Shelter is a critical determinant for survival in the initial stages of a disaster. Beyond survival, shelter is necessary to provide security, personal safety and protection from the climate and to promote resistance to ill health and disease. It is also important for human dignity, to sustain family and community life and to enable affected populations to recover from the impact of disaster. (Sphere 2011).

There are different types of shelter and housing in post-quake phases. This indicates that housing in each stage need to be adjusted in accordance with the living conditions and residents' situation.

People who are homeless because of disaster need somewhere to live while they rebuild their houses, or find alternative accommodation. Shelter and reconstruction therefore happen in parallel, rather than consecutively. The pioneering approach of transitional shelter acknowledges that reconstruction takes usually between two and five years, but that a tent (as emergency shelter) only lasts for around one year. (Shelter Center 2010)

More secure shelter in a safer settlement constitutes immediate and sustainable physical foundation to livelihoods development, including through enabling protection and reducing risk. Poor decision-making can result in a return to the vulnerabilities that resulted in the disaster in the first place. It can also create unsustainable settlements. (United Nations 2008)

Transitional shelter provides a habitable covered living space and a secure, healthy living environment, with privacy and dignity, to those within it, during the period between a natural disaster and the achievement of a durable shelter solution. (Corsellis et al. 2005).

Transitional shelter should be durable enough to last the entire transition period, until reconstruction is complete, and should be able to be upgraded or relocated to different sites. It should use simple techniques and rapid construction methods appropriate to the environment and community with which it is being implemented.

A transitional shelter program begins in the first days of the emergency, with the first distribution of shelter Non-Food Items (NFIs) such as plastic sheeting. These items can be combined with further distributions of shelter NFIs to build shelters durable enough to last the entire reconstruction period. (Shelter Center 2009)

3. HOUSING RECONSTRUCTION EXPERIENCES IN IRAN

In this section housing reconstruction in two case studies in Iran including Manjil Experience (1990) and Bam Experience (2003) is discussed.

3.1. Manjil earthquake experience

The Manjil Earthquake affected Gilan and Zanzan Provinces in northern parts of Iran. The earthquake occurred on June 20, 1990 with $M_w=7.3$ at 00:30 am (local time). This earthquake destroyed three cities (Rudbar, Manjil and Loshan) and about 700 villages. More than 15000 people were killed and more than 30000 people were injured. Also more than 500000 people became homeless. Among affected people the 6.3 per cent were in urban areas and the others were in rural areas. About two hundred thousands of residential and non-residential buildings were damaged.

This earthquake has affected relatively large areas in the region and even was felt in Tehran (225 km southeast of epicenter) which caused fear and panic.

3.1.1. Emergency and temporary housing

Public buildings such as schools had damaged highly so these places could not be used as emergency shelters. In some affected cities the residents were settled in schools but after a few months they had to

leave these buildings due to the beginning of the academic year. In most damaged cities and villages the affected people could not be settled in public spaces and therefore they had to live next to their demolished houses in unsuitable conditions for a while. Due to population dispersion in affected areas, provision of the basic needs and security was very difficult for responsible authorities.

Later on, tents were distributed among households as emergency shelter but some households received more than one tent and some others did not receive anything. In some cases some households had to live in one tent together. Due to the spread of the affected areas and dispersion of damaged villages, it was very difficult to set up emergency camps and even in cities where such camps were set up; people were reluctant to move into them. There were not enough emergency baths and toilets in emergency camps that cause problems for the residents.

For temporary settlement different methods were considered as cash donation and distribution of construction materials, contribution in preparing small temporary housing through local sources and provision of prefabricated houses. Although the authorities intended to prepare the temporary houses during summer and before the beginning of cold season but in many areas especially rural areas, people had to live in tents for several months.

3.1.2. Housing reconstruction

To accelerate the reconstruction pace, different provinces in the country formed auxiliary taskforces and each taskforce was appointed to complete the reconstruction work in its territory by three years. Therefore, many provinces in the country got involved in reconstruction of the affected areas and many technical and administrative sources could be used. (Taleb 1993)

The auxiliary taskforces were responsible to provide construction materials. They evaluated the requirements and prepared the materials. It was decided that the construction materials be delivered to households. But due to some reasons such as inability of the responsible institutes to prepare the materials, inability of some areas in providing proper materials and delays in materials delivery in some areas, residents of the affected areas had to provide materials by themselves from inside and outside of affected areas. For example, some people cut some forest trees and constructed their houses in a traditional style. This indicates that the same vulnerable buildings were constructed. On the other hand, the prices of construction materials increased after the earthquake, thus the survivors encountered further challenges in reconstructing their damaged houses. (Daneshjou 1993)

3.1.3. Reconstruction highlights

Since constructing resistant houses was the focus in this reconstruction experience, the model plans were used. These model plans had the same design and materials regardless of the social and economic status of residents. Considering the Iran's earthquake standards at that time, the structure's resistance was a function of materials and construction style. Consequently similar designs were built that were far from desires of local residents. In some cases in order to adapt the conditions of new built houses with social status, residents added some spaces inside their houses after the reconstruction; see Fig. 1.

In rural areas assigning the reconstruction work to rural residents and confining the outside help to financial and materials' contribution and technical supervision, were important elements in accelerating the reconstruction work.

In urban areas people expected more contributions from government due to the authorities promises to help them in reconstruction. This means that even if they had the financial power to reconstruct their own houses, they preferred to use the public sources instead and consequently did not use their power and abilities.

If the auxiliary taskforces could attract people participation in reconstruction, more success would be achieved. There were military organizations in taskforces that work centrally without considering community participation. Such organizations have an up-down structure that has no congruity with community participation. During reconstruction phase, these organizations could not decide on how to assign the work to people. (Taleb 1993)



Figure 1. Examples of adding spaces to houses by residents

3.1.4. Reconstruction challenges

There were different challenges in housing reconstruction in this experience such as:

In reconstruction work, the non-native labors worked and consequently not only the reconstruction expenses increased but also the local residents did not get job as well. Difficulty in securing the technical staffs and lack of familiarity and experience of other staffs such as informed and skillful builders led to constructing the same vulnerable houses in some affected areas.

Some auxiliary task forces imported some types of designs and construction materials that had no integrity with the affected society. This was due to unfamiliarity with the living conditions in affected areas and consequently some problems appeared as well.

Although some task forces used model plans for construction but some others did not use them. In such cases, people had to start construction based on their own potentials, needs and knowledge that mostly were vulnerable to potential earthquakes.

Since there were many differences in social and geographical characteristics of the affected areas, the unique reconstruction method caused problems. Lack of technical knowledge about proper construction methods among authorities in affected areas, led to high vulnerability of buildings and this indicates the importance of awareness on technical knowledge for different groups. Some damaged residential units in cities located on landslide or rock fall prone areas. In such areas, the landslide risk, or rock fall would be predictable and if people were aware about the potential risks, they would never construct their houses in such areas and consequently the damages would reduce as well.

At the time of this event, there has not been any earthquake or hazard insurance in Iran. The only existed insurance was fire insurance in which the natural hazards damages had been considered as well. Only limited numbers of private buildings had insurance against fires and natural hazards. Besides, damage compensation for such buildings had many challenges due to unfamiliarity with damage compensation mechanisms by insurers. Lack of comprehensive insurance at time of the event led to imposing much pressure to residents and government. Due to high levels of damage and the government limitations in gratuitous aids, some policy makers considered the importance of earthquake insurance after the event but not much was done to develop earthquake insurance in the country.

3.2. Bam earthquake experience

Bam is a small city that is located approximately 200 km southeast of Kerman City (the capital of Kerman Province).

The earthquake occurred on December 26, 2003 at 05:56 am (local time), of $M_w=6.5$ in south-west of Bam City. This earthquake caused catastrophic damage to the Bam city and neighboring villages with a collective population of about 142,000. More than 26,000 people were killed, 30,000 were injured, up to 75,000 left homeless, and 85 per cent of the housing and infrastructure were destroyed.

The 2003 Bam earthquake heavily damaged Arge-e-Bam. Arge-e-Bam (Bam Citadel) was an example of a typical Iranian large urban complex of ancient earthen architecture in an arid environment and one of the tourist attraction centers in Kerman Province. The level of destruction was about 70 per cent on major parts of this huge monument; see Fig. 2.



Figure 2. Arge-e-Bam in post-quake

In Bam city, the adobe structures were mainly concentrated in northeastern part of the city, which is near Arge-e-Bam and gradually spread in central parts of the City. In older parts of the city and inside residential zones, there are too many adobe structures. These types of structures damaged highly and most of them collapsed.

Steel structures used as public buildings such as banks, public organizations, hospitals, and mosques that were mainly located in central parts of the city. The main reasons of structural damages for these types of structures were neglecting building codes in construction and using improper materials and design standard.

3.2.1. Emergency and temporary housing

Due to high damage to public buildings and schools, these buildings could not be used as shelters so, emergency and temporary settlement were held in tents and prefabricated houses. Since there were many people whose houses were destroyed and because of limitations in preparing temporary houses, people had to live in tents for several months. (Khazai et al. 2005) The tents had been located near destroyed houses based on people's wish; see Fig. 3. So, they could protect their properties and also could use the facilities provided by the government. Some people moved to the camps that were held by the Red Crescent. But these camps mainly occupied by the tenants and immigrants from neighbor villages to Bam.

Living in Tents for long time had many difficulties and caused problems for people. Due to climatic situation in the region with cold winters, hot summers and desert storms with sand, it was very difficult to keep tents warm or cool. The temporary baths and toilets had caused unsuitable hygienic condition. Some people pitched their tents near schools in order to use the schools' facilities. Safety and security for residents in the tents especially for tents resided by only women and children was an important problem.

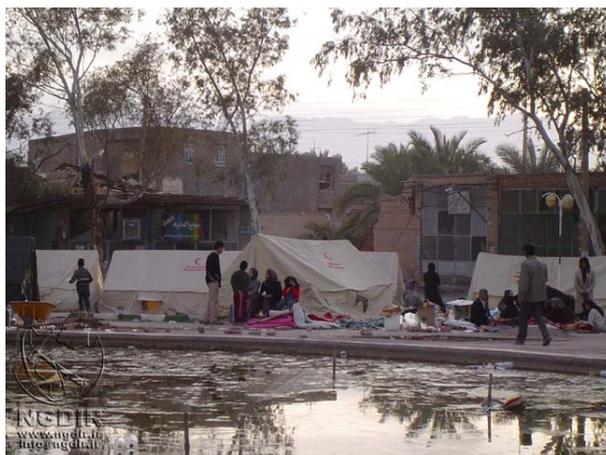


Figure 3. Tents were held near destroyed houses

The other types of temporary houses were prefabricated houses in camps and also near destroyed houses. The primary decision was to construct the majority of temporary houses in the camps outside of the City. But because of residents' and local authorities' objection, it was decided to construct 10,000 residential units in the camps. These camps mainly occupied by the people who had come from other places. Based on the statistics about 36000 temporary houses were constructed in the Bam City, about 9000 units constructed in the camps around the City. It should be mentioned that more than 3000 units in the camps were vacant and people didn't move into them. (Khazai et al. 2005)

3.2.2. *Reconstruction plan of Bam*

The reconstruction process in Bam City was based on a planning process that was the first time in reconstruction experiences in Iran. The Ministry of Housing and Urban Development prepared the reconstruction plan and the Armanshahr Consulting Company was assigned to prepare the comprehensive and structure plan of Bam City. (Armanshahr 2004) This plan was the basic guide for reconstruction and the quality of reconstruction and included the social, environmental, visual, and physical aspects. Based on Bam's structure plan the least changes should be done in the city's spatial organization. Therefore, the traffic routes would have the same width.

On-site construction was as a basic strategy in comprehensive and structure plan of Bam City. So avoiding the City's relocation due to its cultural, identical, and ecological features was an important priority.

Economy's revival during reconstruction in Bam's comprehensive and structure plan was considered for the first time in Iran. The agriculture and gardening sectors could recover quickly due to palm and orange trees. (Behzadfar 2005)

Although in comprehensive and structure plan of Bam some appropriate social and cultural studies have been done but the earthquake risk prevention and management have not been considered properly. In comprehensive and structure plan of Bam, the earthquake risk considerations are only about fault rupture zone and the building codes for construction. Other issues such as buildings arrangement or distribution of emergency response facilities like emergency routes, hospitals, or rescue and relief centers that are effective in earthquake risk reduction were not taken into consideration.

3.2.3. *Executive organization and reconstruction policy*

The main constitution for planning and policymaking was "Bam Reconstruction Guiding Task Force". The task force members were the authorities of the reconstruction responsible organizations. The main activities of the task forces were promoting community participation, creating suitable situation for scientific and technical institutes to participate in reconstruction and improving the construction quality in the affected areas. (Hassani 2004)

The Bam Reconstruction task force approved the reconstruction policies: (Housing Foundation 2004)

- Policies on construction management and people's participation: the construction management of housing units was assigned to people and the Housing Foundation was appointed as executive body of reconstruction and the government representative in reconstruction process.
- Financial policies: These policies included provision of loans with low interest rate to construct earthquake resistant housing units.
- Policies on housing square: based on reconstruction plan approval, financial aids were allocated to construct 80 square ^m² in cities and 60 square ^m² in rural areas.
- Policies on construction technology: including design standards codification to improve quality of construction by the Housing Foundation, recognizing local capabilities in damaged areas and presenting practical methods to promote construction technology in damaged areas.
- Policies on production of construction materials: these policies were based on local sources so would be applicable for native labor, economically would be reasonable, and environmentally would be sound.
- Policies on organizational and bureaucratic matters: These policies included population distribution in cities and villages, avoiding parallel activities by different organizations and accelerating bureaucratic affairs.
- Policies on design and planning: including designing based on people's will, appreciating the people work in reconstruction and avoiding from improper changes and relocations.

3.2.4. *Reconstruction highlights*

From the beginning, the reconstruction authorities and the United Nations Development Program (UNDP) emphasized on community participation, protecting native identity and resistant construction and education to achieve sustainable outcomes, but there was no understanding about participation and its phases among involved organizations in reconstruction. Therefore, there was no planning to promote community participation during reconstruction.

From the beginning, non-native labors did all construction activities and many native contractors had not received their contract cards until several months. Consequently, there were many unemployed people in the affected region that this situation intensified the existed problems.

Some decision makers had come from other cities and due to their unfamiliarity with the culture and people's expectations, some problems arose. Besides, since the reconstruction taskforces staffs had access to suitable food and living environment while people had to deal with many difficulties, after a while people were reluctant to cooperate with them.

3.2.5. *Reconstruction challenges*

There were some challenges in this experience such as:

Due to hard working conditions in the affected areas, some contractors left the region for a while. In such situation, one alternative was increasing the contractors' income and the other one was to solve other problems. Considering the limited funds for reconstruction, increasing incomes was impossible and the second alternative had many complications because of administrative difficulties in affected areas. Consequently, the difficult working conditions sustained for long time. Also due to owners' mental situation and existed reconstruction regulations, some problems appeared between residents and contractors. The main difficulties were Lack of efficient legal system for problem solving, insufficient administration for financial problems even for little amounts of money. Owners expected too much from contractors and consequently interfered in construction process. This was due to owners' wide range of authorities, since the contractors' remuneration was due to owners' confirmation or receiving the construction materials was due to owners' presence, the contractors had to obey the owners' wishes.

There were some difficulties in management and supervision. (Segalpouyan 2004) Lack of experienced managers at middle levels led to slow movement of reconstruction. Also lack of experienced supervisors, although it was necessary to select the most experienced supervisors, some inexperienced people who were doing their national service were employed as supervisors. Too many supervisors in each project reduced the coordination and speed of projects. Generally, for a private housing project the supervision is during foundation completion, structure completion, finishing etc. In Bam reconstruction, the supervision turns were more than the mentioned ones.

Lack of precise plans for registered plots increased the possibility of building relocation from the registered plot. In such situation, the constructed building could be worthless.

The estimated expense for each house in Bam was much less than the real one and in such situation the contractors not only did not profit but also incurred as well. The authorities declared that since the development projects in Bam City were reconstruction and not construction so the expenses should reduce. While the reconstruction projects are more capital intensive than construction. In fact, the indirect expenses and inflation effects were not taken into consideration. (Segalpouyan 2004)

4. CASE STUDIES COMPARISON

Although there is a long interval between two events but there are some similarities in these experiences. In Bam experience some additions are seen that distinct two experiences. (table1)

Table 1. Similarities and Differences between Case Studies

Similarities	Differences
<ul style="list-style-type: none"> • Dispatching non-native labor to the stricken areas that were unfamiliar with the life and culture of affected people. • Assigning non-native managers and contractors for reconstruction that could not communicate with people properly. • The outline of the reconstruction plans had been prepared in Tehran and consequently there were many difficulties in their implementation. • The affected community could not participate in reconstruction due to lack of any plan in this regard by authorities. • Lack of earthquake housing insurance in both case studies. • Housing plans were not in accordance with the culture and living styles of the affected areas. • The construction method was unique in both events while there was a long interval between them. • Resistant construction was important in both experiences while social and cultural aspects did not considered adequately. 	<ul style="list-style-type: none"> • On-site construction and avoiding relocations: that is very important for affected people and preventing from potential legal problems. • Protecting the City's identity, considering the City's historical background and its importance as a tourist attraction city in the country is essential. • Reviving economy, that affects pacing the disaster recovery and preventing from population emigration to other places. • Considering fault rupture zones and building codes in construction, with due attention to seismicity of the City such actions could reduce the potential damages in future events. • Approving reconstruction policies, if such policies would be implemented in the reconstruction, less disorder would be expected during reconstruction. • Preparing sustainable development prism of Bam, such a prism includes guides for comprehensive reconstruction but executive guides in different parts should be developed and explained sufficiently.

The similarities and differences in two case studies are used in developing some guidelines toward improving the housing reconstruction and recovery.

5. GUIDELINES

Considering the case studies experiences the following guidelines are proposed:

- Developing regional to local reconstruction plans in pre event, Proper reconstruction plans are based on local conditions and sources to achieve optimum results. This indicates that reconstruction plans need to be prepared in pre event. Planning for any reconstruction or recovery plan in after math of disaster due to disturbances and lack of authorities presence could not lead to a comprehensive and appropriate one. For any seismic prone country, it is necessary to include regional and local reconstruction plans in the risk reduction plan. Regional reconstruction plans

necessitate regional vulnerability assessment plans and studies on appropriate construction methods in different areas.

- Integrating socio-cultural aspects in housing reconstruction along with technical aspects, although resistant construction is effective in reducing vulnerability during reconstruction, but neglecting the culture of affected areas could end in vulnerable construction. Adding spaces inside reconstructed houses by residents is an example of disregarding social aspects in reconstruction. Besides, the resistant construction should be understandable by residents and local constructors. This indicates that model plans could not be appropriate for reconstruction since social and cultural characteristics of affected households do not taken into consideration.
- Promoting public awareness about proper construction, the public need to be aware about safe construction methods with the available materials and sources. The public can play important roles in safety of their houses. To achieve this, people should always keep informed through different means with considering their social and economic status.
- Documenting housing reconstruction experiences and challenges, making documentations on previous experiences and challenges in housing reconstruction. If Manjil experiences had been documented properly, same similar challenges would not be observed in Bam experience. Documentation can improve the level of preparedness among reconstruction authorities and administrators to confront the unpredictable situation in post event phase.
- Conducting local sources toward individual housing reconstruction, local sources such as labors, materials and even financial sources are very important in individual reconstruction projects. For this purposes it is important to recognize these sources and adopt some incentive policies to absorb them in reconstruction projects. As in case studies observed people expected the government to start reconstruction even in cases that they owned their own housing. This is because the reconstruction process was based on outside sources. To absorb local sources it is important to recognize local capacities and potentials. Urban comprehensive plans and urban development plans can facilitate the recognition of local capacities. Another important point in absorbing local sources is considering the low-income groups in housing reconstruction projects. Since these groups damage more during disasters, their housing needs should be taken in to account in reconstruction plan. Otherwise, the same vulnerable houses are built in vulnerable locations.
- Improving public participation in reconstruction through community based organizations, public participation is very important in promoting housing reconstruction programs since could conduct local sources toward housing reconstruction. Community based organizations especially in urban areas can work as a medium between residents and authorities. Such organizations can work on welfare activities in neighborhoods units in pre event situation and can prepare residents to confront with probable disasters. These organizations can hold rehearsals for residents on how to evacuate their houses, how to rescue their family members and neighbors or how to handle some secondary disasters such as fire fighting. Besides, these organizations can educate residents on the importance of resistant housing and avoiding from housing construction in vulnerable locations.

REFERENCES

- The Sphere Project. (2011). Sphere Project Humanitarian charter and Minimum Standards in Humanitarian Response.
- Shelter Center. (2010). ALNAP Innovations Case Study No.5 Transitional Shelter: Understanding Shelter from the emergency through Reconstruction and beyond.
- OCHA, Shelter Center, DFID. (2008). Transitional Settlement and Reconstruction after Natural Disasters.
- Corsellis, T. and Vitale, A. (2005). Transitional Settlement: Displaced Populations, Oxfam Publishing, Oxford.
- Shelter Center. (2009). Transitional Shelter Guidelines.
- Taleb, M. (1993). Rural Participation in Reconstruction of the Earthquake Damages areas. *8th International*

- Seminar on Earthquake Prediction*. Research Center on Natural Disasters Countermeasures, Tehran.
- Daneshjou, F. (1993). A Study on Supply and Demand of Construction Materials in Earthquake Stricken Areas, Housing foundation and the United Nations Development Program, Tehran.
- Khazai, B., Hausler, E. (2005). International shelters in Bam and Permanent Shelter Reconstruction in Villages Following the 2003 Bam, Iran. *Earthquake Spectra*, 21 (S1), S487-S511.
- Armanshahr Consulting Engineering Company. (2004). Comprehensive Plan of Bam City, Tehran.
- Behzadfar , M. (2005). Historical Sites, *Abadi Journa* PP .82-96.
- Hassani, N. (2004). The Necessity of Revising Earthquake Disaster Management in Iran. *Iran-Japan Workshop*. Management and Planning Organization, Tehran.
- Housing Foundation. (2004). Report on Bam Reconstruction, Reconstruction Office, Tehran.
- Segalpouyan Consulting Engineering Company. (2004). Contractors situation in Bam Reconstruction Trend.