

Principles of settlement management after earthquake (case study: settlement of people after Bam city earthquake)

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Abstract

Natural disasters, especially earthquake have always been the cause of innumerable life and property damages in different countries including Iran. Among the most significant challenges posed to disaster-hit people, the authorities involved in reconstruction and rehabilitation immediately after disaster is how to settle the homeless or out sheltered people. Despite previous experiences, inattention to logical predictions and necessary foreseen estimates concerning settlement issue unfortunately leads to making decisions that contain flaws and setbacks causing not only waste of expenses and time delay in bringing residential units into service, but are also associated with discontent of the people who are suffering consequences of a natural disaster. Accordingly, in this research work, attention shall be paid firstly to the general concept governing settlement issue and then some social, cultural and welfare aspects regarding different methods of settlement shall be investigated. At the end, some samples of various settlement schemes in the Bam city following the 2003 earthquake shall also be discussed.

1 Introduction

Iran is among the countries that owing to special geographic and environmental conditions including location on the world earthquake prone belt is mostly subject to natural disasters such as earthquake and flood that frequently cause destruction to buildings and residential areas and infrastructures in cities. Obviously some other countries in the world like Iran are exposed to this problem, but they have taken precautions to minimize damages incurred by natural disasters. This issue has been taken into consideration by construction industry strategists of the country in the last few years, and significance of retrofitting building against earthquake has been relatively realized in recent constructions, but since great portion of the existing and old buildings are executed without observing correct principles, it is expected that they will be vulnerable to earthquakes, with regard to previous experiences. It is hence

required that necessary precautions are taken in settling those who may be damaged and out sheltered due to probable future natural disasters so that in case of real occurrence, relief and settlement efforts may be done as fast as possible, resulting in reduction of predictable probable damages.

2 Settlement after disaster

Previous experiences in the country show that one of the most significant damages incurred by various natural disasters is destruction of people's permanent housing. In cases where intensity of building destruction is high and possible resurveying with respect to building systems (or services) and/or life and property safety of inhabitants is not feasible, settling damaged and out-sheltered citizens becomes the first priority after medical relief, in the activity agenda of the authorities. In this context, considering conditions of the area and available and accessible resources, settlement is implemented in three consecutive steps emergency settlement, temporary settlement, and permanent settlement.

2.1 Emergency settlement

Following occurrence of disasters like fire, flood, and earthquake it is required that immediate rescue/ relief, and sentiment operations are implemented for disaster victims. The time period normally envisaged for early (emergency) settlement is less than 24 hours. Significant factors like climatic conditions, regional geographic position, population, and so on are effective on this issue. Obviously, lack of on time availability of emergency resources would lead to an increase in fatalities in harsh climatic conditions like freezing and cold weather.

Emergency settlement normally implemented right after occurrence of disaster is by help of tents. This type of housing clearly does not fulfill the usual and everyday life requirement of disaster victims. As it is seen from the name, tents can only provide for emergency needs of the people. However, for a number of reasons like unavailability of proper time and space conditions for temporary settlement, disaster victims may have to live in tents for several years before moving to permanent housing built during tent period. Inevitably, in this case, acute living conditions of tents for such long period would have great problems and consequences (mostly unavoidable) for inhabitants.

Considering the extent of damages and devastations and the estimated time necessary for rehabilitation/ reconstruction, and permanent settlement, different mechanisms are offered in natural disasters.

In cases where damaged building does not structurally have adequate safety, and that the time needed before permanent settlement is beyond two months to one year, authorities shall think of a temporary strategy rather than emergency settlement which consists of tents. In this situation activities and cooperation of relevant organs and entities (national and foreign) and contribution of victims to provide necessary resources to fulfill real needs and to help return to natural life routine are directed towards creating some sort of housing called temporary housing. The dates indicated are the last dates for the respective submissions and returns.

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- 26 July: comment on reviewed papers to authors
- 16 August: submission of papers for publication

2.2 Temporary housing

Vulnerability of tents to heating and cooling and other dangers like fire and also its inadequacy in providing basic necessities of daily life during few months justifies the need for an interim stage between emergency settlement and permanent settlement called temporary settlement.

In other words, great volume of damages incurred, the need of survivors to a relatively appropriate and safe environment until resettlement, and necessity to create opportunity for planning and correct execution of rehabilitation measures justifies the need to resettle disaster victims in temporary housing, which is mostly done in the form of two strategies:

- 1- Creating camps and complexes of temporary residential units on a flat ground near disaster areas in the configuration of temporary settlement complexes. These areas are named "guest town".

A guest town in real fact, consist of areas inside a city or its suburbs in which a great number of similar residential units are built up adjacent to one another so as to resolve settling needs of certain sectors of the society, like flood hit, earthquake stricken inhabitants, and or tourists in a temporary manner (less than two years). In these small townships, primary facilities such as commercial centers, early medical services and open playgrounds for kids are provided.

- 2- Creating temporary housing units on yards or on the ground adjacent to the destructed units, individually

Certainly each of the above two strategies have their own advantages and deficiencies on which not only time-space conditions, but socio-economic characteristics of the people of that region are largely effective.

In the first method, creation of camps or complexes at the center of or on the boundaries of cities guest town, a usual name for such towns may be associated with the following consequences:

- 1- Because of lack of contribution on the part of community forces to build such camps, conditions are provided for production society and for generative forces of the society to turn into consumer society.
- 2- Distribution of food materials and other needed essentials among victim society tends to trigger certain habit of urbanization, which has little compliance with needs and nature of disaster victims.
- 3- Unemployment and unsatisfied instinctive needs provide proper motivation for social and cultural delinquencies.
- 4- Residential units being too close to each other produces undesirable disturbance in personal privacy of inhabitants.
- 5- Providing housing and ready food for the victim community tends to reduce their participation and their motivation for cooperation in securing control and in organizing the affairs.
- 6- Lack of employment opportunity and or entertainment for youth brings along physical and psychological damages.
- 7- Deployment of such camps on the side of main and heavy traffic roads may adversely affect health and safety of the society.
- 8- Construction of camps and complexes on the city outskirts provokes gradual migration of rural population toward cities. In other words, following the temporary settlement period the units built on the suburbs of megacities shall be associated with unpleasant consequences.
- 9- If for any reason majority of the people settled in the camps are not able to resettle back in cities, such that only some wealthy families emigrate back and the rest stay in the surrounding boundaries, consequent social and moral anomalies may be expected.

It is worth noting that creation of camps is advantageous in certain cases like when large portion of the neighborhood has collapsed and destructed, and that removal of detritus is associated with difficulties

and is time consuming, where it can be counted as an adequate mechanism to settle destruction victims. Some of the advantages are the following:

- 1- Construction of temporary settlement units next to each other is implemented with higher speed.
- 2- Possibility of presenting services for well being of the inhabitants is done more simply and easily.
- 3- Life and property safety control is provided more easily.
- 4- Possibility of distributing primary services and aids, appropriate to different needs of disaster victims is provided.
- 5- Deployment of various medical teams in such camps creates the possibility for presenting medical services on extensive level and with higher quality.
- 6- Relief and rescue is provided more fairly, observing equality in distribution of goods and services.

2.3 Permanent settlement

Simultaneously with temporary settlement, (or emergency settlement when temporary settlement is not considered) it is necessary that policy makers involved with reconstruction of damaged areas consider mechanisms for permanent settlement. In this context, the most significant criteria to be paid attention to for assessing the final objective in permanent settlement are as follows:

- 1- Geological studies are implemented to identify ground layers constituent materials and their performance against possible forces.
- 2- Attention to urban development principles
- 3- Architectural design of buildings appropriate to climatic, geographical, and cultural conditions of the region
- 4- Presenting rehabilitation methods for existing buildings, and retrofitting new ones against natural disasters
- 5- Making maximum use of capabilities and potentials of the region including manpower, factories, production industries, and other factors
- 6- Proper usage of temporary settlement towards reaching permanent settlement

3 Settlement after earthquake

In this section, there will be a quick review of Bam Earthquake in Iran and then settlement procedure for the disaster victims of this region is described.

3.1 Bam earthquake

At 1:56:56 GMT (5:26:56 local time) on early morning Friday 25-Dec-2003 an earthquake with magnitude 6.6 on Richter scale destroyed the Bam city in Kerman province. The greatest earthquake intensity was estimated equal to 9 in Modified Mercalli scale. Among the most significant reasons for high destruction intensity in this region, two factors may be named:

- Earthquake focal depth close to ground surface at a distance of about 10 Km deep
- In some parts of the Bam city, vertical component of the earthquake was estimated close to 8g.

Because of the Bam earthquake most adobe buildings (Accounting for more than 50 percent of this region buildings) and also many steel and concrete buildings with unsystematic construction are either totally collapsed or seriously damaged. Buildings constructed with observance of the current design

and execution regulations and criteria may have been damaged but are not collapsed. The old citadel of arg-e-Bam (largest world adobe monument with nearly 2000 year history) is almost totally destroyed. Some samples of earthquake destruction is shown in Fig.1 and 2.



Figure 1: Extensive destruction of adobe buildings due to weakness of materials against lateral forces



Figure 2: Destruction of concrete and steel structure buildings near earthquake epicenter due to incorrect erection

3.2 Settlement of disaster victims

Based on an order from the president, reconstruction management of the region is entrusted to the Islamic housing foundation. In this context, reconstruction of Bam is defined in three steps (emergency, temporary and permanent settlement) [1].

Executive client of the Red Crescent emergency settlement project and that of the ministry of interior project were appointed. Time duration of 1 to 2 years was envisaged for temporary settlement so that following this period people are settled permanently. The executive client for permanent settlement project was also appointed to be Islamic housing foundation.

Shortage of necessary space to dump demolition waste (or rubble), and shortage of traffic roads for waste-carrying trucks are among major difficulties of waste removal in this disaster area such that each collision led to four hour delay in schedule. Considering increase in air temperature, uneasy living conditions in a tent, and occurrence of hazards like fire, installation of precast units was considered as a solution to improve living conditions. Deployment of such units provided for benefiting facility resources like air-cooler, Frigidaire, clean water, and sanitary services. However, because of shortage in resources only an 18m unit was allocated to each household regardless of the number of people in the family, which is not large enough space to remedy all living needs of the household.



Figure 3: Emergency settlement of disaster victims near damaged building

On the other hand, temporary settlement was supposed to be deployed in camps, at the beginning. Furthermore, inadequate space for waste removal trucks maneuvering, and outspread of virus worsened the situation. As a result, all temporary settlements were being implemented in guest towns. Following preparation of camps, discontent people were not willing to settle in guest towns. That is why authorities were convinced to change strategy from guest towns to garden houses. This change of strategy brought along a 45-day delay in settlement schedule while it boosted costs to a certain extent. Therefore, close to 33 thousand households were to be settled in garden houses and almost 10 thousand others in guest towns.



Figure 4: Some samples of guest towns on the margins of the Bam city which are usually empty of population

In general, during close to eight months after earthquake, approximately 33000 residential units with average under-construction area of 18m² (equivalent to 594000 m² space area) have been built and

delivered to inhabitants. Some examples of temporary settlement plan in the Bam city are given in the following images.



Figure 5: prefabricated temporary housing made with fiberglass(18 m²)



Figure 6: steel structure prefabricated houses with brick walls(18 m²)

4 Recommendations for design and execution of temporary housing

It seems, various temporary settlement strategies, based on two essential ideas:

- 1- Facility and speed of execution
- 2- Economic aspects

Although the above two basics are considered by policy makers for reconstruction plan as the required conditions of settlement, but they are not sufficient and other effective aspects are to be accounted for. Post earthquake settlement experience in Iran has shown that other significant factors were also effective in this connection:

- Compliance of architectural design with climatic and geographical conditions of the region.
- Coordination of architectural design with cultural characteristics of the people of a region
- Flexibility of buildings with respect to decrease or increase in the under-construction area of each residential unit suitable for the needs and the number of persons in household
- Motivating sense of public participation and persuading disaster victims to build shelters
- Using available resources and accessible construction materials of the region to make temporary housing.

Observance of the above issues leads to making more efficient use of time and costs, and more importantly that victims are satisfied with reconstruction trend and are mentally and psychologically relieved.

In this context the following reconstruction based on research and investigations on settlement schemes after earthquake in Iran are recommended:

- 1- It is necessary that temporary houses have adequate strength and stability against natural forces like earthquake and aftershocks. In view of the fact that utilities and equipments, and also technical personnel and quality control tools are not accessible in the region for a long time after disaster, it is essential that elements of main structure of the building are designed and cast in the factories so that they can be transported to the disaster site to be quickly assembled there, or that structure producing plant may be portable enough to be transported to the site and start making parts with good quality. Evidently, installation and erection of such structures triggers community participation in disaster area and increases speed of execution
- 2- Temporary residential units are so designed as to provide for benefiting from local and available building materials as non-load-carrying elements and fillers or partitions like walls, ceiling and

floor coatings. In other words, main structures of the building must be flexibility enough so that it would make possible to install various nonstructural elements like walls, and ceiling or floor covers. This leads to more effective utilization of potentials of the region so that community participation is improved. Previous experience in Iran has shown that the need of disaster victims to shelter in some cases leads to development of interesting intuitions and inventions in making use of local materials towards fast implementation of temporary housing.

- 3- Temporary houses must be designed such that they could be arranged next to each other as modules with specified sizes. This is to mean that construction area of the units are reduced or increased according to needs. Obviously the number in the household is a decisive factor in the surface area of a temporary unit. Also, justifications must be provided so that inhabitants (or disaster victims) are tempted to return to their previous living conditions with more mental and psychological relief. One of the most important such provisions is existence of adequate space to feel the relief because as it was mentioned earlier temporary housing is intended for about one or two years of residence for disaster victims, as they often seek for larger housing surface area of temporary units as they recuperate from the primary three months of hardship following occurrence of earthquake disaster.
- 4- Although sanitary services are essential for living, but because of critical conditions following the earthquake and due to inability to observe clinical issues and especially inaccessibility to clean potable water and enough water for washing they are preferably installed as stand alone units in a suitable distance from residential units so that health of inhabitants is not threatened. Clearly as sanitary services are not installed close to or adjacent to residential units, it may bring along hardships for kids and elderly, especially in wintertime, but this is unavoidable.
- 5- Temporary residential unit roofs in the form of pitched roof shall provide for easy employment of moisture and thermal insulations and so inhabitants would be better relieved.
- 6- Application of bolted connections instead of welded ones in structural and even nonstructural elements would reduce the need for building implementation tools and machines to a minimum. Local and community participation speeds up implementation process without need for welding machinery. In bolted structures, on the contrary to welded ones the possibility to displace or move the entire structure or portions of it exists more easily and freely.

5 Summary and conclusion

In most developing countries, construction industry is not associated with good quality and normally suffers high life and property losses against natural disasters like earthquake. In this context, it is necessary for policy makers to provide required estimates concerning disaster victims' settlement before occurrence of these natural phenomena.

The most significant consequences of such carelessness are:

- Waste of time and costs in reconstruction
- Increase fatalities due to disasters
- Increase physical and psychological damages to disaster victims

Forethought of relevant authorities before disasters regarding design and implementation of temporary settlement with adequate flexibility concerning environmental, cultural and social conditions can considerably reduce the consequences of such disasters. In the present research work some of the very important basics required in design and implementation of temporary housing that has adequate flexibility in various conditions are recommended.

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