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RECONSTRUCTION OF TOWNS AND CITIES AFTER DESTRUCTIVE EARTHQUAKES: CHALLENGES AND POSSIBILITIES FROM THE URBAN DESIGN POINT OF VIEW

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ABSTRACT

In recent decades, several old towns and cities, particularly the historical cities in developing countries have been heavily damaged by earthquakes. The destruction of the city of Bam in the Kerman province of Iran, by an earthquake of magnitude 6.5 in 2003, is a good example in this regard. The reconstruction of these cities, particularly the historical ones, is of great importance for the corresponding countries, and to some extent, for the world community. However, the lack of sufficient global experience in this issue has caused several problems for reconstruction authorities, and it is likely that new problems emerge in similar future cases. This paper tries to look at the reconstruction project from the urban design point of view, focusing on: 1) The concept of reliable or "disaster-avoiding" urban design; and 2) The differences between reconstruction of an earthquake-stricken existing city and developing a new one. The requirements for achieving a seismically reliable urban design, discussed in the paper, include: population studies; lands ownerships identification; estimating the space needed for housing and offices, public and commercial areas, health and relief centers, urban activities as well as lifeline systems; location determination for the mentioned spaces based on urban design criteria in a seismic area; architectural design of spaces; and finally structural design of city components. Emphasis is put on the use of hazard microzonation maps of the city among the urban design criteria. Careful attention should be paid to the components of lifeline systems including energy, water and wastewater, transportation, and communication systems as well as the special buildings such as public and government buildings and rescue and relief centers. Using the proposed approach is believed to be useful for achieving successful reconstruction plans in case of severe damages to another city by a major earthquake.

Introduction

In recent decades, earthquakes in developing countries have proved that several old towns and cities, particularly the historical cities, are highly vulnerable to even moderate earthquakes. The destruction of the city of Bam in the Kerman province of Iran, by an earthquake of magnitude 6.5 in 2003, and the Balakoot earthquake in Pakistan in 2005, are good examples in this regard. On the other hand, although retrofitting the vulnerable buildings and replacing the aged texture of old cities are the most effective ways for seismic mitigation, they need special technology, expertise, and a remarkable budget, which are not available sufficiently in most developing countries. This means that the mitigation process is very time

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consuming in these countries, and therefore, it is very likely that another destructive earthquake will happen in some of the cities in these countries before any mitigation project has taken place. Besides, it is clear that having no plan for reconstruction of a stricken city, not only the reconstruction process will take longer, but also the authorities will tend to speed up the reconstruction because of the community pressure, which leads to disregarding many urban design principles, finally resulting in an unpleasant reconstructed city with several urban shortcomings. Considering these points, it is clear that having the reconstruction plan in advance is a very crucial issue in highly seismic regions.

Several studies have been conducted with regard to reconstruction issues so far. However, the early studies have been mostly concentrated on specific cities rather than on the general issues and principles that should be followed in every reconstruction planning process. As an example, Muto (1963) has conducted a study on relocation and reconstruction of the city of Skopje, which was damaged by the earthquake of 26 July 1963, and earthquake engineering problems in Yugoslavia. Another example is reconstruction planning for Tangshan city after the 1976 Tangshan, China earthquake (Hou 1982). He has made particular reference to the anti-seismic planning process, and has put forward some proposals aimed at reducing possible earthquake disaster through municipal planning. Some other issues taken into consideration by researchers are the governmental aspects of reconstruction (Jones 1982), and the importance of lifelines and urban planning aspects in seismic protection of historic town centers (Lagorio 1985).

Systems study concepts have been also been used in the study of urban response and reconstruction due to catastrophic earthquakes (Kozin and Zhou 1988 and 1990a and 1990b). They have developed an applied formulation of lifeline restoration processes in the post-earthquake period on the basis of a discrete-state, discrete-time, Markov process to minimize the total loss caused by the earthquake. They have used dynamic programming to optimize the distribution of limited reconstruction resources, and have examined various scenarios by computer simulation, and have obtained the information that is important to the emergency management authority.

In a study performed on post-earthquake housing reconstruction in Mexico City after the September 1985 earthquake, by calling the case “making of a new paradigm”, two functional characteristics of housing reconstruction, namely the broad-based decision-making process and its policy-oriented organization, have been discussed as sources of significant innovations in the realization of three important goals of the program: the economic basis of financial arrangements, the physical upgrading of housing, and safeguarding, and the social and economic fabric of the community (Pantelic 1989). The reconstruction of Mexico City has been studied by Santa-Maria (1991) as well. Mentioning that by The Housing Emergency Reconstruction Programs in a period of eighteen months were 48,000 dwellings rebuilt, the author has claimed that the project provided fertile ground for technological and organizational innovations and became a natural laboratory for innovations which generated experiences and experiments.

Koff et al. (1990) have elaborated a geo-informational model for Leninakan area of Spitak, Armenia, using the methods of statistical processing, probabilistic analysis and unclear multitude theory. They have evaluated the response to seismic effects by a number of buildings with various damage rates, and by regression analysis, have classified objects to establish damage degree, and to carry out zonation of the city using the damage degree. Their mathematical model includes: a) the multidimensional space of geological parameters and b) indices of seismic impact on construction objects, and the following criteria have been used as seismic impact indices of the construction objects: the total quantity of damaged buildings, different degrees of damage according to the seismic scale adopted in the former U.S.S.R.

The effects of lifelines’ interaction on the speed and cost of the urban system reconstruction has also been studied (Zhang 1992). He has proposed an approach to take into consideration the interaction among lifeline systems in studying the strategies for urban system service restoration after a destructive earthquake. He has modeled the restoration of each lifeline system as a Markov process, assuming that the degree of effect that a certain lifeline has on the restoration of some other lifeline is a function of its critical state and its current expected state.

Greene (1993) has briefly reviewed some of the major housing issues that have emerged in recent urban earthquakes in California, focusing on the Loma Prieta earthquake. Housing assistance programs and public policy issues in housing provision after urban earthquakes are the major topics discussed in that study. Arnold (1993) has studied reconstruction from a qualitative rather than an administrative viewpoint. Most of this study concerns city planning, and much of it is historical. In sketching some of the planning background that has set the context for post-earthquake reconstruction, his intent is not to develop new historical hypotheses but to outline current historical thinking and relate it in time to the reconstruction effort. The core of that study is the four case studies of reconstruction of Tokyo after the 1923 earthquake and fire and after the 1945 bombing; China after the 1976 earthquake; Spitak, Armenia in 1988, after the earthquake; and Santa Cruz, California in 1989, after the Loma Prieta earthquake.

A comparison between the conception of the city reconstruction after the earthquake and the reconstructed city has been made based on the devastating Tangshan, China earthquake (Cai and Sun 1996). A state-of-the art application of a logical combination of geographic information systems (GIS) and artificial intelligence (AI) to urban planning for earthquake disaster mitigation has been also presented (Wang and Wang 1996). A database for an expert system and diagnostic programs under conditions of reconstruction has been also introduced (Chachava and Lekveishvili 1996). They have analyzed the existing information on historical sites of cities and have studied the history of construction of seismic-resistant buildings. They have also introduced an expert system using a database on architecture and town planning, and have made corrections during reconstruction and have designed alternative projects.

Another case of reconstruction studies is with regard to the Kobe earthquake, where more than 240,000 buildings collapsed (Preuss and Arnold 1998). They express that a variety of mechanisms have been used for Kobe. These include re-planning and replacement of neighborhoods, involving changes in spatial layouts of blocks; replacement of groups of buildings, changes to the existing parcel and street layout; individual buildings not necessitating changes in street layout. Kobe reconstruction has been also studied in comparison to the reconstruction after the Northridge earthquake in a joint work of the U.S. National Science Foundation and Japan Society for the Promotion of Science (Lee et al. 1998). This study focuses mainly on three areas of research: transportation systems; water systems; and emergency communications and management. Another study with regard to the Kobe earthquake has been carried out by Koura (2000), who has worked on the actual conditions and reconstruction progress in the Ashiya area, believing that each area of the city have its own disaster countermeasures and plans. The author has claimed that the characteristics of recovery conditions differ with districts depending upon the history of land use, conditions of housing sites, and characteristics of the area. Shimizu (2000) has also studied the Kobe reconstruction and has introduced the concept and progress to that date for the reconstruction of the affected downtown areas through land readjustment projects, urban redevelopment projects, and so forth, as well as the strengthening of disaster management functions that have been implemented together with the urban reconstruction projects. Finally, Kobayashi (2000) have reported that 4 years after the Kobe earthquake, the focus of urban issues was shifting from urban reconstruction to community development. In this report it is mentioned that when the physical reconstruction advances, new urban issues arise. These include dealing with the restoration process; that is (1) a plan and systems for comprehensive urban restoration; (2) restoration of the community; and (3) treatment of vacant land and redevelopment of the townscape.

Another case of reconstruction studies relates to the January 2001 Bhuj earthquake in Gujarat state, India with about 300,000 collapsed houses and 700,000 damaged ones (Jain and Jaiswal 2002). The authors have stated that the handling of the building stock immediately after the earthquake posed a serious challenge to an administration that was not prepared for earthquake emergencies. Reconstruction of Skopje is another interesting case (Arkovski 2003). Arkovski has stated that the processes of development of Skopje have always been conditioned by unexpected limiting factors and have had important cultural values in the course of their millennium-old evolution, and that after 1963 earthquake, Skopje has become a city exhibiting a new and successful scientific methodological basis for urbanization of cities in high seismicity areas.

A few years ago a Post-Disaster Urban and Housing Reconstruction Manual was introduced (Murosaki 2003), which suggests that reconstruction planning be taken as a component of the master plan of the city. Finally, just recently in another study with regard to Kobe, a Time-Sequence Analysis has been introduced for restoration /reconstruction process (Enomoto et al. 2006).

The present paper tries to look at the reconstruction project from the urban design point of view, focusing on: 1) The concept of "disaster-avoiding" or reliable urban design, and 2) The differences between reconstruction of an existing city and developing a new one. Emphasis is put on the use of hazard microzonation maps of the city among the urban design criteria. Special attention has been paid to lifeline systems as well as special buildings. It is believed that paying attention to the issues discussed in the following sections of the paper will be useful for achieving successful reconstruction plans in case of heavy damages to another city by a major earthquake.

The Concept of "Disaster-Avoiding" or Reliable Urban Design

There are some main issues in urban design, such as function, compatibility of function with time and space, accesses and ease of movement, safety and security, environmental issues, aesthetic aspects, character, continuity, quality and enclosure, legibility, adaptability, and diversity, which every designer considers in his/her work. However, if the effects of natural and even man-made hazards are not taken into consideration in the design process, the urban environment will not be capable of providing the citizens with the expected services in the case of hazardous situations, and as a result the occurrence of such hazardous events will lead to disasters. In other words, the design will not be "disaster-avoiding" or reliable. In fact, there are some special issues, which should be taken into consideration, to achieve the reliable or "disaster-avoiding" urban design. These include:

- estimating the space needed for urban components in a seismic area,
- location determination for urban components with earthquake considerations,
- architectural design of urban spaces with earthquake considerations, and finally
- seismic structural design of the city components, including buildings and facilities

In the following sections some explanation is given for each of the above issues.

Estimating the Space Needed for Urban Components in a Seismic Area

Obviously, there are some criteria for estimating the required spaces for various urban components, considered for different usages, including buildings, open and/or public areas, and access roads. However, in a seismic area, there are some special components which are not necessarily considered in non-seismic areas. These include "crisis management head office" in a special setting in relation with the lifeline systems main offices, as described in the next section of the paper, "open areas for emergency as well as temporary shelters", "special warehouses for housing the basic goods for emergency situations", and so on. Furthermore, the spatial features of some components should be different to achieve "disaster-avoiding design" of a city in a seismic area. For example, the access roads to hospitals should be much wider to facilitate the concurrent movement of several ambulances, or the large buildings should have much larger open areas around them to be used for emergency shelters.

Location Determination for Urban Components with Earthquake Considerations

Locations of various urban components, including residential areas, working places (government and private), and spaces for other activities, and so on, and finally, urban facilities and utilities should be not only based on the main urban design criteria, but also based on the disaster-avoiding design criteria. In this regard using the seismic microzonation maps is very essential. These maps which are prepared for different levels of seismic hazard (50%, 10% or 2% probability of exceedence in 50 years), can be categorized into three main groups. The maps of the first group, which are called "iso-seismal maps", show the maximum values of the surface response parameters in various parts of the city. These parameters are Peak Ground Acceleration (PGA), Peak Ground Velocity (PGV), and Peak Ground

Displacement (PGD). The second group includes the maps showing natural period and/or dynamic period of the soil in various parts of the city. The third group of maps illustrates the occurrence probability of various ground instabilities or soil permanent deformations, including surface rupture, land slides and lateral spreading, large settlement, and liquefaction. It should be pointed out that the microzonation maps are usually prepared by considering all seismic sources located in a pre-decided radius around an urban area. However, for some design purposes, particularly those which relate to the emergency activities in the aftermath of the earthquake, the source-specific microzonation maps should be used. For example, in urban transportation system, component-wise design should be based on the general hazard microzonation maps, but function-wise design should be based on the source-specific maps.

Another important point is the special role which urban planners and urban designer can play with respect to lifeline systems. As explained in another paper of the author, (Hosseini and Niazi Shemirani 2003), lifelines can have a double-folded “disaster-mitigation/disaster-creation” effect in the aftermath of an earthquake. This very important Seismic Risk Mitigation (SRM) aspect of lifeline systems should be considered in both urban planning and urban design. In the following subsections, the important role of urban planning and design, with regard to this aspect of lifeline systems are briefly explained for new cities. The case of existing damaged cities is discussed in the next section of the paper.

The SRM Role of Urban Planners with Regard to Lifelines in New Cites

Urban planners, who are the main decision makers on the number/volume and the location of urban components, including those of lifeline systems, can play their SRM role in the following ways:

- Site selection for lifeline systems key components such as dams, power plants and so on, not only based on the general urban and regional planning criteria, but also by paying attention to the seismic hazard level considered in the region according to the regional seismic hazard macrozonation maps;
- Considering more access ways, particularly ways with lower seismic hazard level, for cities specially the major ones, which have been planned, by some rationalization, to be located in highly seismic areas; this will make it possible to have more certain rescue and relief activities for serving the people who need help in those area, regarding the vital role of transportation system in the successfulness of rescue and relief teams activities in the case of a major seismic event in an urban area.
- Considering the less seismically vulnerable energy supply system for under-planning urban areas; this decision making can be performed effectively by a close cooperation of urban planners and lifeline engineering specialists.
- Considering more appropriate large open areas around densely populated districts of the city by predicting enough urban utilities access for temporary settlement after the seismic event; this will decrease the probable life loss in the case of a major earthquake, and will somehow hinder the social impact of the event.
- Considering the compatibility between site selection for future satellite town around a big city and the lifeline route to that town by the proper use of the seismic hazard maps; this is a very important point with regard to site selection for future development that even when the selected site for a town is seismically safe, the routes of lifelines to that town can be improper, namely the utilities have to pass hazardous areas to reach there.

The SRM Role of Urban Designers with Regard to Lifelines in New Cites

Urban designers, who are responsible experts and decision makers for configuration and orientation of urban components, can play the SRM role in the following ways:

- Considering the compatibility between site selection for the city components and the lifeline route to that component by the proper use of the seismic hazard microzonation maps; this is a very important point with regard to site selection for future urban components, because sometimes even when the selected site for a component is seismically safe, the routes of lifelines to that component can be improper and the utilities have to pass hazardous areas to reach that component.
- Considering the proper configuration and orientation for the city lifeline components, such as bridges and tunnels, as well as a proper route for the passage of extended lifeline components such as power

transmission lines based on the detailed seismic hazard maps.

- Designing the major city component, including the lifeline key components in such a way that the adverse interaction between different lifeline systems is kept at the possible minimum level; this needs a close cooperation of urban designers and lifeline engineering specialists.
- Designing the urban transportation network, as the most important lifeline for rescue and relief activities, in such a way that it is not likely to get damaged by other interactive lifeline systems and other city components.
- Designing the large public complexes and buildings such as sport complexes, malls and so on in such a way that they can give the sufficient service up to their capacity, to the probable stricken people. In other words, these places should have a flexible architecture giving them the possibility of presenting a dual performance, one as their routine daily services, and the other as their emergency action services.
- Designing a crisis management complex, comprising all the offices mentioned before in the safest place of the city, with highly assured inter-access and communication possibilities, as well as considering the required security issues.

Architectural Design of Urban Spaces with Earthquake Considerations

Living in an earthquake resistant city requires having earthquake resistant buildings, and the architectural design of buildings with earthquake considerations is an inevitable part of the earthquake resistant design. In this regard, there are some general provisions or recommendations for earthquake resistant architecture which is beneficial for every building. However, there are some additional rules or considerations in architectural design of special buildings, such as rescue and relief centers, public buildings, and so on, following which makes the seismic behavior of these buildings and post-earthquake functionality much more reliable (Hosseini 2003).

Seismic Structural Design of the City Components, Including Buildings and Facilities

The last step of seismic resistant urban design is the seismic structural design of buildings and facilities, for which there are several codes and standards in different countries. However, in many developing countries, the building codes or standards belong to another country, or have been copied form other existing codes and standards, and most of the time they are not necessarily well-matched with the technical and economical characteristics of the developing countries. In the case of codes and standards for seismic design of facilities in developing countries, the situation is even more crucial, due to the fact that they are still under preparation in developing. Therefore, an attempt is required by the experts of earthquake engineering in each one of developing countries to develop their national seismic design codes by considering the technological, economical and cultural conditions of their own country.

The Differences between Reconstruction of a City and Developing a New One

There are some differences between the design of a new city and the reconstruction design of an existing earthquake-stricken and severely damaged city, particularly with a new number of residents (if the earthquake has resulted in high casualty). These differences imply the consideration of some new topics in addition to the four above-mentioned issues, explained for the disaster-avoiding design as follow.

- population studies (present and future),
- land ownerships identification after the event,
- debris removal planning
- identifying the components which should be rehabilitated or rebuilt in their previous locations
- identifying the components which should be relocated
- identifying the components which should be added to the city, and
- planning the transition from emergency sheltering to permanent housing.

In the following sections some explanation is given for each of the above issues.

Population Studies (Present and Future)

It is clear that if an earthquake results in large number of casualties, there will be an influx of new residents in the stricken city, however, it is most probably incorrect to think that the population of the city after the event will be less than before its happening. In cities with a large number of villages around them, particularly if these villages get damage due to the earthquake, it is very likely that many of villagers, especially those who lose their homes, move to the city, in order to secure their livelihoods and receive their basic needs, and after all decide to stay in that city for ever. On the contrary, some of the citizens may decide to leave the stricken city and move to larger one, particularly if their homes are destroyed and numbers of their family members are killed which sometimes leave them with hosting some close relatives from other cities. These migrations from villages to town and the main city and from the stricken city to other cities should be certainly considered as a crucial factor in the estimation of the future population of the city.

Land Ownerships Identification after the Event

When there is vast destruction of homes and very large number of casualties, it is very likely that much of the lands remain without any owner after the earthquake. Some claims may show up later by next of kin of the dead, who have been injured because of the earthquake and have been under treatment for a long time, or even some of their relatives who live in other cities. It is also likely that some false claims grow by people who have not owned any land before the event, and take the opportunity of using the unclaimed lands. These problems are very crucial and although they are not related directly to urban design, they can result in several difficulties facing reconstruction authorities. Solving these problems requires the cooperation of law and social science experts with the authorities.

Debris Removal Planning

In case of extensive destruction of buildings in several parts of the stricken city, there will be a huge mass of debris in the city which not only makes several difficulties for search, rescue and relief teams, but also hinders the temporary sheltering and permanent housing of the people. Recycling the debris materials can be an appropriate way to get rid of the huge masses, however, it needs a very deliberate in advance planning and proper management in the aftermath of the event so that the reconstruction of the city can take place on time. Debris recycling needs some plants or small factories to be added to the urban components around the city, and this needs a special planning and design attention. These plant can get smaller is size or number after a while and continue their work as waste recycling plants.

Identifying the Components which should be Rehabilitated or Rebuilt in their Previous Locations

When a big earthquake occurs, many urban components in various parts of the city might get damaged, and this may vary from minor damage (you can not use damages or plural) to complete collapse. Depending on the extent of damage and the location of the damaged component, the reconstruction authorities can decide on rehabilitation or demolition of the components. Obviously, if the damage to a component is minor and the location of the component is appropriate based on the microzonation maps, it is reasonable to be rehabilitated. Furthermore, the historical buildings and monuments are among those components which should be kept in their previous places. It may also happen that a building with just some minor damage does not locate in an appropriate place. In such cases, changing the function of the building (with necessary architectural modifications, if possible) can be a rational solution.

Identifying the Components which should be Relocated

As explained in the previous section, the extent of damage to the urban components due to earthquake may vary from minor or no damage to complete collapse. However, some of the key urban components may have been located in inappropriate locations (cases of improper site selection), according to hazard microzonation maps. In such cases, even if the extent of damage is very little and changing the function of the component is not possible, the component should be removed form its original location and a new component should be constructed in an appropriate location. In fact, the earthquake which leads to great losses to the city at the same time can create an opportunity for implementing the modified (disaster-avoiding) master plan of the city resulting in having a resilient city against future events.

Identifying the Components which should be Added to the City

In old cities, the lack or shortage of some components, which are necessary according to the new urban design criteria is likely. For example, the number of fire fighting stations may be less than enough. Furthermore, even many of the recently developed cities which have not designed based on the seismic urban design or "disaster-avoiding development" may not have the "Emergency Management Center", which is a very important component in a city located in a seismic area. Adding all of these necessary components should be a part of reconstruction of an earthquake stricken city. The lifeline systems or their components may be among the missing components that a new city should have. In this regard, similar to new cities, urban planners and urban designers can have important roles in SRM, as explained hereinafter.

The SRM Role of Urban Planners with Regard to Lifelines in Existing Cites

In existing cities, the urban planners' responsibilities can be divided into two main categories. One is with regard to those parts of the existing cities, which are planned to be renewed. Here, their role is basically similar to the role in new cities as the old parts of the cities are renewed. Only some modifications may be necessary because of the interaction between the old and new parts of the urban area. The other category of urban planners' responsibility for the existing cities is related to the changes or additions which they can offer to make the existing cities safer against the future earthquakes. These changes or additions can be as follow:

- Considering an Emergency Management Center in the safest location of the city (adding it to the city, if not existing, or changing its location if not located in a safe place), and placing all the crisis management authorities and offices of the city lifeline systems around it, possibly as a complex, or in a way that they have quick access to each other; in order to make the communications or gathering of all the crisis management authorities much easier and safer in the time of the earthquake.
- Modifying the access ways form densely populated districts to large open areas of the city; this will facilitate the evacuation of the stricken people if it becomes necessary after a major earthquake.
- Adding some urban utilities' accesses in the large open areas of the city to be used during the temporary settlement after the probable earthquake; a good example is to consider some elevated water tanks in open areas of the city in order to be used by the stricken people without any need to pumping (electric power shortage is very likely after major earthquakes).
- Modifying the access ways to hospitals, particularly the big ones to expedite the rescue and relief teams' activities and also the access ways of fire departments to densely populated areas.
- Changing the vulnerable energy transmission system; for example, if the electric power transmission towers are located on instable slopes they should be relocated or changed into underground transmission system.

The SRM Role of Urban Designers in Existing Cites

As mentioned for urban planners' SRM role in existing cities, urban designers' responsibilities can also be divided into two main categories; one with regard to those parts of the existing cities which are going to be renewed, and another is related to the changes or additions which designers can offer to make the existing cities safer against the probable future earthquakes. In the latter category, the following modifications can be proposed:

- Redesigning of Emergency Management Complex based on the aforementioned points;
- Upgrading safety of the access ways from densely populated districts to large open areas of the city;
- Designing some safe urban utilities access to be added to the existing system in the large open areas of the city in order to be used during the temporary settlement;

- Upgrading the safety of access ways to hospitals, and those of fire departments to populated areas;
- Redesigning the major city component, including the lifeline key components for decreasing the adverse interaction between different lifeline systems; and
- Upgrading the seismic safety, or altering the performance of unsafe important buildings which are related to lifeline systems.

Planning the Transition from Emergency Sheltering to Permanent Housing

The last issue which should be taken into consideration in rebuilding of an earthquake stricken city is the gradual change or transition of people lifestyle from living in tents or temporary shelters to their permanent housings. The presence of the people itself is a very important issue. Obviously in the time of construction of a new city, there is no citizen over there, and only the construction people are working in the area while in an existing city, there are citizens with all their basic living needs in the city, therefore, the construction should take place at the same time. This may create several conflicts, particularly if the construction work is massive and widespread throughout the city. Hence, the reconstruction authorities should have a very deliberate plan for replacing the temporary shelters with the permanent houses. In this regard, a special architectural design which makes it possible to use the temporary shelter as a part of the permanent housing, either for residence or other usages, is an issue that architects can work on.

Conclusions and Recommendations

There are several types of urban design guidelines, including space oriented, subject oriented, policy oriented, territory oriented, and so on. However, based on the issues discussed in the previous sections of this paper, some specific comprehensive guidelines are required for the reconstruction of earthquake stricken cities, particularly the old and historical ones. The guidelines should not only include any of the desired mentioned orientations for development pattern of urban texture (structure) and grains, density, height, buildings' mass, materials and details and so on, but should also consider the differences of developing a new city and reconstruction of a severely damaged urban area, and having special provisions to construct a resilient city against future earthquakes and even creation of a multi-hazard resilient city, having urban pride, dignity and safety all together. In this regard, there are some issues which need further works, research and studies, among which are introducing the urban components required for higher resilience against earthquake and other hazards, developing source-specific microzonation maps, paying full attention to the double folded disaster-creation/disaster-mitigation role of lifeline systems in both urban planning and urban design, the special dynamic or revolutionary architecture which can combine the temporary shelters with the permanent housing. Using the proposed approach and completing it with the mentioned works and studies is believed to be very effective in achieving successful reconstruction of severely damaged cities by major probable future earthquakes.

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