

RECENT DEVELOPMENT IN EARTHQUAKE RISK MANAGEMENT PLANS AND PROGRAMS IN TEHRAN

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ABSTRACT :

Improvement of the disaster risk management system has been considered as one of the most important priorities in Iran for the related organization during the recent years and especially after the Bam Earthquake of 2003. Due to importance of Tehran as the capital of Iran, and high risk of earthquake of the city, several activities carried out to reduce the potential damages of an earthquake in the city. In this paper one of the plans formulated for this purpose named Tehran Disaster Management Master Plan will be introduced. This plan has been formulated in 2005 for reducing potential damages and improving the capacity of Tehran in emergency response. In this plan different areas of risk management including prevention/mitigation, preparedness, emergency response and reconstruction/rehabilitation have been considered and in each topic the main activities need to be carried out for improving the existing conditions were determined and prioritized. In addition the economical impacts of such improvement were evaluated to facilitate decision making based on the best cost-benefit analysis. In this paper the main components of this plan will be introduced and some of the ongoing projects in this line will be briefly explained.

KEYWORDS: Risk Reduction, Master Plan, Tehran

1. INTRODUCTION

The city of Tehran, the Capital of Islamic Republic of Iran, is located in a seismic prone area in an active part of Alpine-Himalayan Orogenic belt (Alborz Mountain Range) and has surrounded by several active faults. Moreover this city has experienced some destructive earthquakes in its history (figure 1).

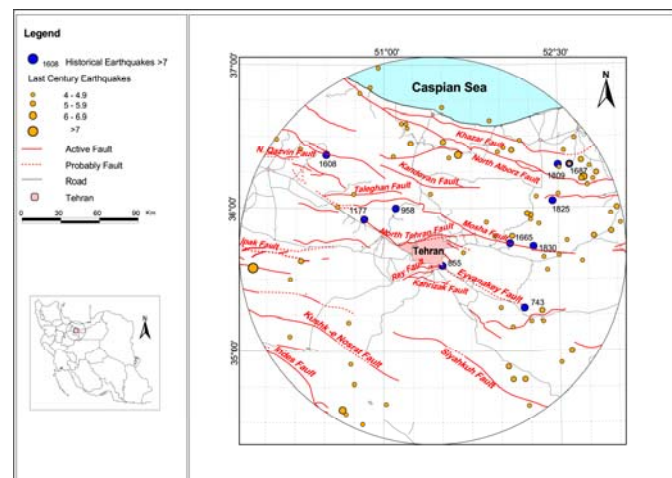


Figure 1 Main faults around Tehran and the location of historical and last century earthquakes around the city in 150km radius (Amini Hosseini and Jafari, 2007)

Evaluations of the tectonic setting and seismicity of the areas show that a strong earthquake could be expected in this area in the near future. On the other hand due to rapid growing rate and insufficient strong rules and regulations for construction in some period of the time specially during the last century, the vulnerability of some parts of the city (especially old parts) are quite high against a potential strong earthquake. In order to reduce the potential impacts of an earthquake, several parameters should be taken into account by related authorities and city managers including applying the seismic standards and codes for new building construction, renovation and improvement old and vulnerable urban areas, development of emergency response capacities, preparing the citizens for a potential disaster, etc. Considering the existing condition, Tehran Disaster Mitigation and Management Organization (TDMMO), one of the subsidiaries of Tehran Municipality, has formulated a master plan for disaster risk reduction in Tehran in the year of 2005 by assistance of Japan International Cooperation Agency (JICA) that have been approved by the related authorities to be implemented in 12 years, started from 2006. Based on this plan, 15 projects have been selected among more than 150 projects to be carried out in different areas of disaster risk management in short to long term period of the time. The main framework of this plan will be introduced in the following parts.

2. CHARACTERISTICS OF TEHRAN DISASTER MANAGEMENT MASTER PLAN

The main goal of formulation and implementation of the disaster management master plan for Tehran is to secure the lives and properties of the citizens against a potential devastating earthquake. In order to achieve the goal, the master plan sets three objectives to accomplish in 12 years including: securing lives and properties of the citizens of Tehran; protecting citizen's life after the event; and preparing rehabilitation and reconstruction plans. To achieve these objectives, ten strategies have been selected including strengthening existing buildings, improvement of existing urban structure, identification of safe evacuation spaces, strengthening existing infrastructure and lifeline, provision of earthquake information and education, establishment of disaster mitigation policy, establishment of community level disaster management organization, improvement of disaster management system, formulation of emergency response plan and establishment of rehabilitation and reconstruction procedure. As it can be observed all aspects of disaster risk management (including mitigation, preparedness, emergency response and reconstruction) have been considered in preparing the master plan.

Considering the seismotectonic setting of Tehran region, three types of earthquake scenarios were adopted for the necessary analyses in this project as follows (figure 1):

- 1- Ray Fault Model: That is related to an earthquake with magnitude 6.7 and maximum PGA equal to 400 Gal in southern parts of Tehran that would be expected due to the movement of Ray Fault;
- 2- North Tehran Fault (NTF) Model: This is an earthquake (magnitude 7.2 and maximum PGA of 400 Gal in northern part of Tehran) that may happen due to movement of North Tehran Fault;
- 3- Mosha Fault Model: Mosha Fault is located in north of Tehran and it may cause an earthquake with magnitude 7.2 and maximum PGA of 200 Gal in northern parts of Tehran.

Among the three scenario earthquakes, Ray Fault Model is estimated to cause the most serious damage in Tehran Municipality. Therefore, Ray Fault Model is the objective earthquake in the master plan study.

3. MAIN COMPONENTS OF TEHRAN DISASTER MANAGEMENT MASTER PLAN

3.1. Mitigation

3.1.1 Strengthening existing buildings

In order to prepare the necessary plans for retrofitting the existing buildings, at first it was necessary to evaluate the seismic resistance of buildings in Tehran. For this purpose sample buildings (including private and public buildings such as hospitals and fire brigades stations) were selected for investigation and pertinent design drawings were collected. The diagnostic method adopted for analyzing seismic resistance was expressed by the Seismic Index of

Structure “ GIs ” obtained from the following equation (Japan Code, 1996):

$$GIs = Qu / (\alpha \cdot Qun)$$

Where, GIs : Seismic Index of Structure
 Qu : Seismic force level for ultimate capacity check
 Qun : Required seismic force level for ultimate capacity check

α : Correction coefficient

By using GIs , it was estimated that considerable amounts of existing buildings in Tehran would be damaged heavily by the target earthquake. It was also revealed that Masonry structure, which is a dominant structure type in Tehran, is particularly weak.

3.1.2 Improvement of existing urban structures

In order to evaluate the vulnerability of urban tissues and structures to potential earthquake, three indices were used as follows:

- Building Damage Index (Ratio of possible collapsed buildings to the total buildings in three scenario earthquakes);
- Evacuation Index (Includes open space area, narrow road ratio, number of evacuees and number of disaster weak);
- Secondary Damage Index (include hazardous facility, gas pipeline damage and electric power cable damage).

Integrated vulnerability was assessed on the sum of the estimated above three vulnerability indices. The results of the analysis are shown in the figure (2). Based on the results of this study several mitigation measures have been developed to be used in different parts of Tehran (considering the prioritization carried out in this study) including urban redevelopment, road and urban infrastructure improvement, area-based building reconstruction and retrofitting, individual building retrofitting and reconstruction.

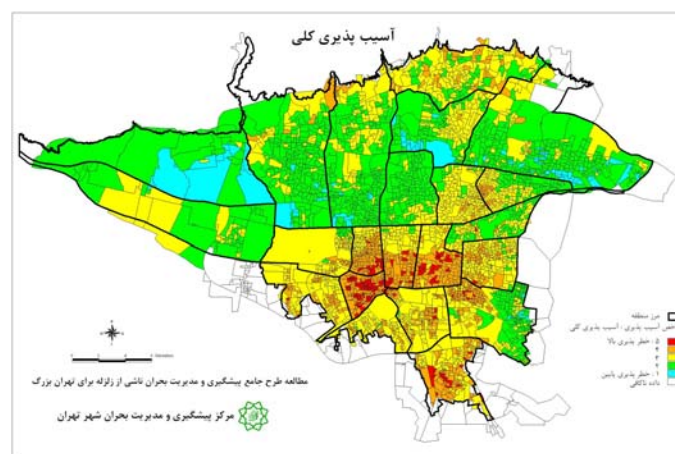


Figure 2 Integrated vulnerability index of Tehran (TDMMO, 2005)

3.1.3 Identification of safe evacuation space

The evacuation system in this study has been divided into two groups of regional evacuation places to be used as mid-long term shelters and community evacuation places to be used in emergency evacuation. Up to now several evacuation maps have been prepared in community level in Tehran that one example is shown in figure (3). Besides of evacuation places, in this component the evacuation and emergency roads were also studied and necessary maps including primary (linking disaster management centers of national, provincial, municipality, district, and sub-district levels with major airport/ground terminals as for transportation nodes) and secondary (linking all the identified emergency response centers of rescue/fire fighting/security, and medical care) emergency roads maps were prepared.

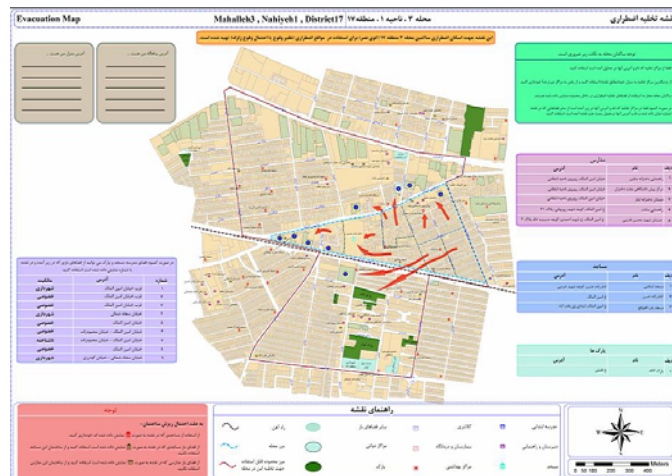


Figure 3 A sample of emergency evacuation maps prepared for district 17 of Tehran

3.1.4 Strengthening existing infrastructures and lifelines

In this component the vulnerability of most important lifelines and infrastructures in the city of Tehran (including main bridges on transportation network, water network and facilities, gas pipelines and related infrastructure, and electricity network and facilities) were evaluated and necessary measures for improvement of their seismic resistance behavior were studied.

3.1.5 Establishment of disaster mitigation policies

One of the best methods for reducing the impacts of disaster is to promote the culture of using insurance for natural hazards. So promotion of using insurance and establishment of the necessary framework for providing reliable earthquake insurance were considered as one of the priorities in the master plan. For this purpose the experiences of other countries such as Japan, the United States, New Zealand, France, Spain, and Latin American countries have been reviewed and used for planning. Besides of the insurance two more measures could be also adopted to assist in promoting private building strengthening including low-rate loan and subsidy. Based on the prepared plan low-rate loan scheme with an annual interest rate of 8% and 10 years of payback period could be applied to cover the cost for building strengthening, considering an annual open market rate of 15% in Tehran. Subsidy could be also applied to cover the cost of building diagnosis and a part of building strengthening cost.

3.2. Preparedness

3.2.1 Provision of earthquake information and education

Promoting the public awareness and education in different levels could play a main role in risk reduction. So, in the disaster management master plan of Tehran, special attention was paid to these issues and some plans and programs were developed in this regard. Some of the carried out activities on this subject include: implementing drills and practices in different public to professional levels, planning for education of government staffs on related issues (such as basic knowledge of earthquake, estimated damages and vulnerability of earthquake in Tehran, laws and regulations related to disaster management in Iran and Tehran, system and structure of disaster preparedness and duties and functions to be managed by each organization, plan of staff responsibilities in case of emergency, system of coordination and communication during the time of crisis, roles of related organizations, etc.), education for school students, education for the general public, social education, etc. (figure 4).



(A)



(B)

Figure 4 Some of the activities for promotion of public preparedness against earthquake in Tehran; (A) Community based training courses, (B) Drills in residential areas by assistance of people and responsible

3.2.2 Establishment of community level disaster management organization

In order to protect life and property of the local people from earthquake damages, individual local resident has to get a concept of self-protection by getting information on earthquake and countermeasures and implement these knowledge at home, in the community and workplaces, etc. These measures for disaster preparedness can be effective if the local community collaborate with existing community organizations such as youth association and women's groups and establish community-based groups of disaster preparedness. For this purpose, local government should support the establishment of community based groups and provide necessary tools and material for them for assuring the sustainability of their activities. At this moment in Tehran several community based organizations have been established by volunteers and by supports of Municipality. One of the successful cases is DAVAM (Neighborhood Emergency Response Volunteers) program. In this program at each neighborhood level, some volunteers were registered and trained to act as emergency response groups.

3.3. Emergency response

3.3.1 Improvement of emergency response system

As mentioned before in master plan, Ray Fault Model was considered as the scenario earthquake. However, the damage estimated to be caused by the Ray Fault Model is extraordinarily huge and sometimes beyond imagination. Of course in planning for emergency response it is acceptable to consider ultimate case, even if this condition is not very realistic. In the master plan several aspects of emergency response were taken into consideration including emergency response commanding; rescue, relief and medical treatment; evacuation, emergency traffic and lifelines availability after the earthquake. Based on this plan, up to now several activities carried out to improve the capability of TDMMO to manage and co-ordinate the emergency response. The most important activities are as follows:

- Improvement the capacity of Emergency Response Command Center (ERCC): The new ERCC of Tehran is now under construction and it is estimated to be operation by end of 2009. This center is equipped with the most advanced technologies necessary for commanding and coordinating including communication system, GIS command software, control units, etc.
- Establishment of Quick Damage and Loss Estimation System (QD&LE): At this time an accelograph network is under installation in the city of Tehran to measure the strong ground motion in real time and

send the data to ERCC for using in damage and loss estimation. The main engine of this system will use the acceleration in different parts of the city after earthquake and by interpolating data and using the data bases on building and population distribution, it can estimate the most affected sites after an earthquake in 20 minutes. Such data can be helpful for allocating emergency response teams in very short time after an earthquake.

- Establishment of Disaster Management Bases: Along with the development of emergency response capacity in the city of Tehran, around 100 bases have been constructed and now are operational for using at the time of crisis for supporting emergency response. These bases at the normal condition are using for different purposes such as Emergency Medical Services (EMS) stations, Fire Fighting Stations, etc. These bases are designed somehow to resist in strong earthquake and could provide services aftermath. In addition the necessary emergency facilities such as electricity, water and telecommunication are installed in these structures (figure 5).



Figure 5 One of the Disaster Management Bases constructed in Tehran

3.3.2 Formulation of emergency response plan

In the disaster management master plan of Tehran, several subjects related to emergency response planning were studied and related plans were developed considering the existing condition and necessary improvement. A summary about these plans are as follows:

- Information Network in Emergency Response: The necessary information at the time of crisis can be divided into two categories, one is for victims and public and the other is for rescue and relief operations. The most important information for the residents are related to the information of earthquake and fire out breaks, information about safety of family, friends and relatives, etc. while the necessary information for rescue and relief operations are related to the information of number of victims to be nursed in each area, road blockage information, notification of designated evacuation route and places and information of commodity supply such as water and food. Now a stable network having large capacities have been established at TDMMO that have connection with 22 district buildings by using different means such as microwave, mobile radio, satellite phone and so on. In addition Tehran Telecommunication Company is strengthening its network to be able to respond to the potential needs of residents after an earthquake to get news from their families.
- Search and Rescue: Resources for search and rescue operation in Tehran are limited and it seems they are not sufficient to cover all needs after a strong earthquake. In order to overcome this problem some plans have been developed at TDMMO to mobilize all the resources over the country and concentrate them on Tehran in the shortest time after an earthquake. For this purpose several auxiliary provinces have been assigned to get the responsibility of emergency response after a big earthquake in specific districts in connection to the national government (figure 6). Moreover as mentioned before, some programs were formulated to use the local resources at community level for response to an earthquake.

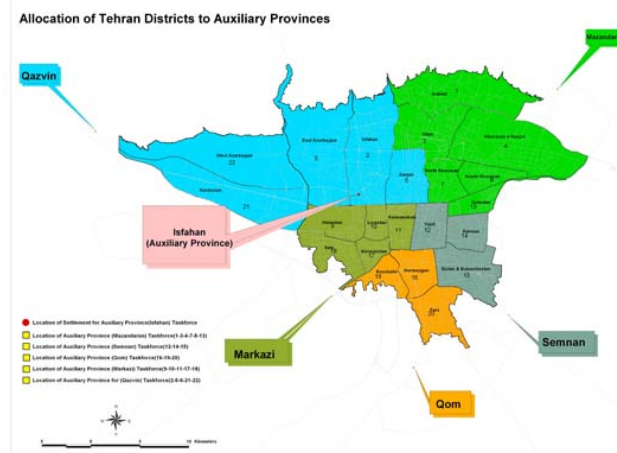


Figure 6 Auxiliary provinces to assist emergency response after a big disaster

- Mass Casualty Management: Tertiary level hospitals need to be protected from being overwhelmed by massive light cases. Establishment of control system of victims' flow from community to hospitals is crucially important for effective disaster management. In the master plan of Tehran establishment of several check points at affected areas or close to the hospitals were proposed including community-based response team and advanced medical posts (AMPs). These stations could provide the first aid and play a role of check point (triage) before sending the injured to hospitals to control their flow.
- Organization and Management System: In Tehran master plan the establishment of an emergency response organization based on Incident Command System (ICS) together with Standard Emergency Management System (SEMS), which is a model for command, planning and coordination after emergency, is proposed.
- Other Plans: Besides of the above mentioned items, in Tehran Master Plan the other important subjects in emergency response including evacuation, emergency traffic, and lifeline serviceability after the earthquake were also studied and formulated.

3.4. Reconstruction

3.4.1 Establishment of reconstruction and rehabilitation procedure

The process for urban rehabilitation and reconstruction in Tehran disaster management master plan has been formulated into 5 chronologically stages as follows:

- Stage 1- Establishing the Preliminary Framework for Urban Reconstruction: This framework should be formulated within one week from the time of the earthquake for confirming the initial framework for the reconstruction of the city.
- Stage 2- Formulation of Basic Policies for Urban Reconstruction: These policies should be decided from one week to one month after the earthquake. During this period the basic policy regarding the reconstruction of the city will be drawn up at the post-disaster reconstruction headquarters in order to make clear the fundamental approach to be taken towards the rebuilding work, and when this has been determined the residents will then be notified of it.
- Stage 3- Formulation of Basic Plan for Urban Reconstruction: This plan should be prepared from one month to six months on. During this period a basic plan will be drawn up for rebuilding the town and with this clarify the both the fundamental plan for the regeneration of the whole of the Tehran City and/or each area that has suffered damage and also the methods for achieving this.
- Stage 4- Confirmation of the Work Program for Urban Reconstruction: These activities should be implemented from six months to a year on. In this stage the work will be conducted towards getting the

agreement of the local residents and create a program of work for the reconstruction based on the basic plan that was formulated.

- Stage 5- Implementation of Urban Reconstruction Projects: This part will be started after one year and may last for several years. In this stage, rebuilding the town will be forwarded based upon the work program for urban reconstruction drawn up in Stage 4. In order to carry this out rapidly, endeavors to secure financial resources will be indispensable.

4. CONCLUSION

Analysis carried out during preparation of Tehran master plan, extracted 150 projects in different fields of disaster management and risk reduction. These projects then were classified considering their efficiency, importance, costs and several other criteria. Base on the results of this analysis, 15 projects have been selected to be carried out in 12 years to improve the existing situation to an acceptable level. These projects are listed in table (1):

Table 1 Priority projects for risk reduction in Tehran

No.	Title of the project
1	Strengthening and Replacement of Existing Public Buildings
2	Promotion of Strengthening of Existing Private Buildings
3	Improvement of Building Quality
4	Promotion of Urban Redevelopment for Disaster Prevention
5	Provision of Regional Evacuation Sites and its Facility
6	Strengthening and Replacement of Bridges along Major Road Network
7	Strengthening of Water Supply Facility and Network
8	Installation of Central Control System for Natural Gas Distribution System
9	Establishment of Disaster Management Educational Center at Tehran Municipality Level
10	Establishment of Community Level Disaster Management Group and System
11	Institutional Capacity Building in Tehran Disaster Mitigation and Management Organization
12	Establishment of Emergency Traffic System in Tehran
13	Installation of New Disaster Information and Telecommunication Network
14	Strengthening of the Capability and Capacity of the Tehran Fire Fighting Organization
15	Strengthening of Emergency Response Capacity for the Governmental Health Organization

It could be observed that the list is cover the most critical subjects in reducing vulnerability of Tehran against earthquake and the projects affecting in promoting preparedness and emergency response capacities. Some of these projects have been started during the last two years and the rest of them are in planning stages.

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