



A COMPREHENSIVE MASTER PLAN STUDY ON URBAN SEISMIC DISASTER PREVENTION AND MANAGEMENT FOR TEHRAN CITY

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SUMMARY

Tehran City is located in a seismically active area and has suffered destructive earthquakes in the past. Haphazard development and rapid growth of the population in the last few decades coupled with poor construction quality and lack of appropriate disaster prevention and management plan has made the city quite vulnerable to future earthquakes. As a result of the study on seismic micorzoning of the Greater Tehran Area that took place between 1999 and 2000, a strong earthquake due to the Ray Fault will cause huge damage to buildings and heavy casualties to people. Based on the recommendations of this study, it was imperative to formulate a comprehensive master plan study on urban seismic disaster prevention and management for Tehran City. The study was carried out with the cooperation of Center for Earthquake Studies of Tehran and Japan International Cooperation Agency. The plan is formulated based on the planning issues such as: Urban disaster prevention plan; Earthquake resistant structure measures for buildings and infrastructures; Community development plan for disaster management; Preparation of earthquake disaster management plan; and Formulation of disaster management programs and projects. The planning approach of the study includes: Investigation of building structures; Importance of planning process; Community disaster management plan through people's participation; Preparation of earthquake disaster prevention and management plans; and Integrated approach for program and project formulation. This paper presents the details of the formulated plan.

Keywords: Preparedness; Recovery; Urban Planning and Risk Analysis; Disaster Prevention; Disaster Management

INTRODUCTION

Tehran City is located at the foot slope of the Alborz Mountain Ranges that form part of the Alpid-Himalayan Orogenic Zone, which is a high potential earthquake zone, having many peculiar active faults. According to the historical seismic data, Tehran has suffered from strong earthquakes at 150-year return period. Seismologists predict a strong earthquake will hit Tehran in the near future, because the City has not experienced any disastrous earthquake since 1830.

A Comprehensive Study on Seismic Microzoning of the Greater Tehran Area was conducted between 1999 and 2000. As a result of that study, it is pointed out that a strong earthquake caused by the fault activity of the Ray Fault will largely affect Tehran City. Huge seismic damages to both buildings and people are estimated, especially in the Southern part of Tehran City where dense populations and traditional non-resistant buildings are dominant.

The lives and properties of the citizens of Tehran will be made safer from a potentially devastating earthquake by formulation and implementation of a comprehensive disaster management plan. Urban development has been rapidly progressing in Tehran without the

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development of a proper disaster prevention system against potential earthquakes.

Following to the Seismic Microzoning study, a Comprehensive Master Plan Study on Urban Seismic Disaster Prevention and Management for the Greater Tehran Area was initiated in April 2002. The Study proceeded in 3 phases to achieve the following sequential study objectives:

Phase 1

Comprehensive Diagnosis of Disaster Prevention and Management Situation in Tehran

Phase 2

Preparation of the Master Plan for Urban Seismic Disaster Prevention and Management in Tehran

Phase 3

Preparation of an Action Plan for the Implementation of Urgent Priority Projects and Programs

BASIC POLICY OF THE STUDY

Goal

The goal of the master plan is to establish a safe and secure urban environment against a potential earthquake. In order to have a more concrete mitigation target, the study proposes to reduce the number of damaged buildings to one- ten of the estimated damage in the Ray Fault case. .Ultimate target damage caused by the Ray Fault Model is 48,000 buildings, which should be strengthened or rebuilt

Planning Period

The implementation plan was divided into three phases:

Short term (2004-2006)

Medium term (2007-2010)

Long term (2011-2015)

The master plan will cover the years 2004 to 2015, or a total of 12 years. However, ultimate goal of the mitigation target cannot be achieved within the planning period. It will take 80-100 years to achieve this goal. Within the planning period, more than 100,000 buildings should be strengthened to reduce the earthquake damage.

Objectives

In order to achieve the goal, the Master Plan sets three objectives to accomplish by the year 2015. The objectives are:

- to secure lives and properties of the citizens of Tehran;
- to protect citizen's life after the event; and
- to prepare rehabilitation and reconstruction.

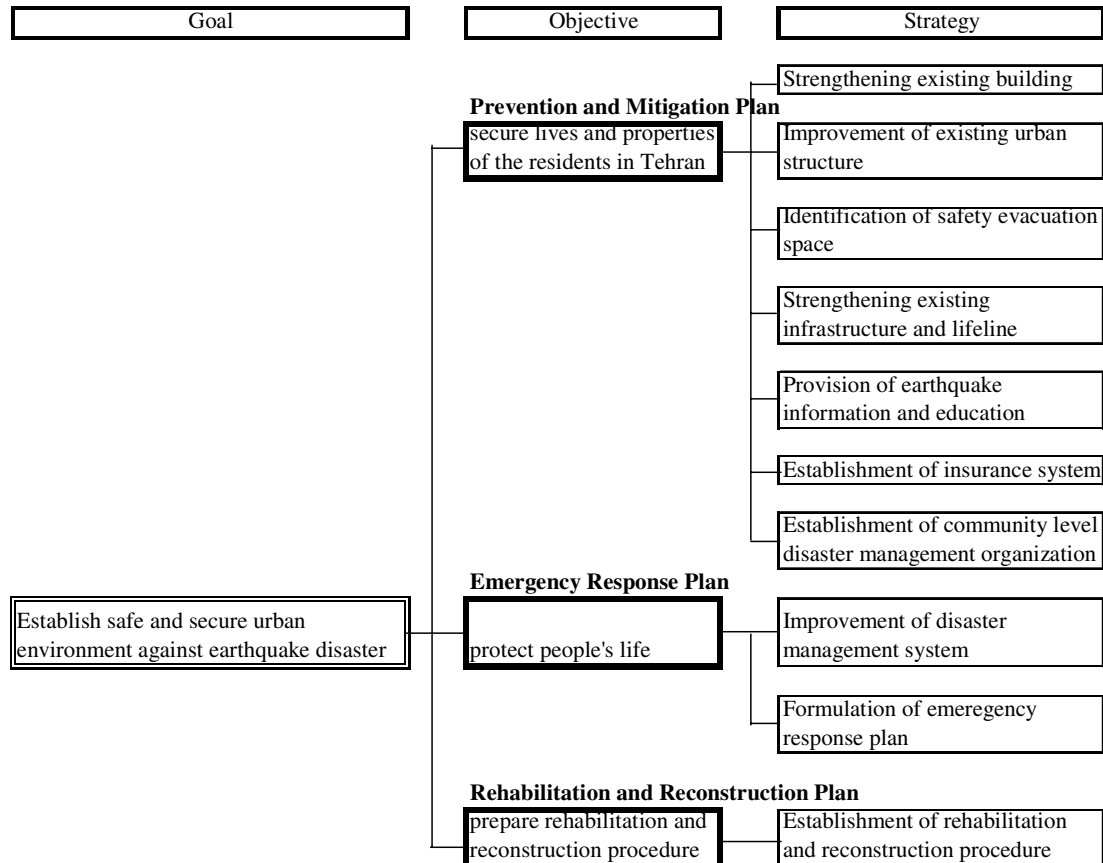
Strategies

To achieve the objectives, ten strategies are selected as follows:

- Strengthening existing buildings
- Improvement of existing urban structure
- Identification of safety evacuation space
- Strengthening existing infrastructure and lifeline
- Provision of earthquake information and education
- Establishment of insurance system
- Establishment of community level disaster management organization
- Improvement of disaster management system
- Formulation of emergency response plan
- Establishment of rehabilitation and reconstruction procedure

Framework of the Master Plan

The framework of the master plan study can be organized as shown below.
The three objectives are in correspondence with three plans: prevention and mitigation plan, emergency response plan and rehabilitation and reconstruction plan. The ten strategies are classified dependent on earthquake countermeasure.



CONDITIONS FOR THE MASTER PLAN

Objective Earthquake

Three types of scenario earthquakes, namely Ray Fault Model, North Tehran Fault (NTF) Model, and Mosha Fault Model were adopted for seismic microzoning analyses. Among the three scenario earthquakes, Ray Fault Model is estimated to cause the most serious damage in Tehran. Therefore, Ray Fault Model is the objective earthquake in the master plan study.

As a result of the damage estimation, damages to residential buildings and human casualties are summarized below. The number of existing buildings and population were assumed at 876,000 and 6,360,000, respectively.

	Ray Fault	NTF	Mosha Fault
Length (km)	26	58	68
Magnitude (Mw)	6.7	7.2	7.2
Peak Ground Acceleration (gal)	North<200 South>400	North>400 South<200	<200
Intensity (MMI)	North: 8 South: 9	North: 9 South: 7-8	7
Bldg Damage	483,000	313,000	113,000
Damage Ratio	55%	36%	13%
No. of Deaths	383,000	126,000	20,000
Death Ratio	6%	2%	0.3%

Economic Damage Analysis

The effects of an earthquake event can be broken down into three: the economic cost, the human cost including loss of life and personal injuries and the ecological cost among other damage to ecosystem. The economic loss caused by the earthquake can be categorized into three items: direct loss, indirect loss and secondary effects of the earthquake.

Direct Loss

In order to estimate direct loss, previous study results are used. As for the building damage, the replacement costs of each building type are estimated based on the existing building construction practice. The total direct damage by the heavily collapsed buildings is US\$ 23.5 billion. The total direct damage by the bridges and lifelines is US\$ 29.7 million, and US\$ 8.8 million, respectively.

Indirect Costs and Secondary Effects of Earthquake Damage

Those costs are estimated using available statistical data and the experience of other countries. The indirect damage is estimated at US\$ 9.2 billion. Secondary effects of the earthquake damage are estimated at 1.0 percent to 1.2 percent of total GNP, or approximately US\$ 1.2 billion.

Total Damage

Total economic impact of earthquake of Ray fault model is summarized as follows:

Direct loss US\$ 23.5 billion

Indirect loss US\$ 9.2 billion

Secondary loss US\$ 1.2 billion

Total Loss US\$ 33.9 billion

Total damage of the earthquake is 57 percent of the GNP of the nation.

Emergency Response Costs

Emergency response costs include emergency response costs to Tehran residents, removal of debris, and temporary shelter provisions. The total costs are estimated at US\$ 2.9 billion.

Rehabilitation and Reconstruction Costs

The rehabilitation and reconstruction costs are estimated to cover 31,000 ha, or 44% of the Tehran city. In financial terms, it is about US\$ 195 billion, or 3.4 times of the country's GNP.

Economic Analysis of Earthquake Damage Estimation

Target of damage reduction level is one-tenth of Ray Fault Model's estimated building damage. In order to achieve this goal, the government and private sector should spend money on earthquake damage mitigation measures. When the damage amount is reduced, emergency response and rehabilitation and reconstruction costs are reduced as well.

SECURE LIVES AND PROPERTIES OF THE CITIZENS OF TEHRAN (DISASTER PREVENTION AND MITIGATION PLAN)

STRENGTHENING EXISTING BUILDINGS

Building Investigation

In order to gauge the seismic resistance of buildings in Tehran, building investigation was conducted. The sample buildings for investigation were selected as follows, and pertinent design drawings were collected.

Building Types	Sample Nos.
Public Facilities	Major public facilities 70
	Hospitals 80
	Schools 100
	Other public facilities 10
Residential buildings	Southern part of Tehran 10
	Central part of Tehran 40
	Northern part of Tehran 40
Total	350

Note: Major public facilities include municipality, fire brigades and police offices. Other public facilities include libraries, museums and theaters.

Results

By using seismic index of structures, it was estimated that 50% of existing buildings in Tehran would suffer heavily damage by the target earthquake. It was also revealed that Masonry structure, which is a dominant structure type in Tehran, is particularly weak.

IMPROVEMENT OF EXISTING URBAN STRUCTURE

Disaster Management Map and District Diagnosis Sheet

In order to assess the availability situation of existing disaster preventive resources, a Disaster Management Map was prepared by district based on the collected data from district level. District disaster diagnosis sheet is prepared to show the resources and vulnerability level of each district.

District-wise Diagnosis for Earthquake Vulnerability

In order to evaluate the vulnerability for earthquakes district-wise, three indices, which are Building Damage Index, Human Casualty Index, and Evacuation Resource Index, are used for the evaluation.

Building Damage Index:

Possible highest rates of collapsed buildings to the total buildings resulted from the previous study under the three scenario earthquakes.

Secondary Damage Index:

The variables include hazardous facility, gas pipeline damage and electric power cable damage.

Evacuation Resource Index:

The evacuation includes open space area, narrow road ratio, number of evacuees and number of disaster weak.

Results of Diagnosis

Integrated vulnerability is assessed on the sum of the estimated three vulnerability indices of building collapse, people's evacuation and secondary disaster.

Regional Characteristics of Urban Vulnerability

It would be appropriate to evaluate the relative vulnerability of Tehran city in an integrated manner as a whole, yet it is insufficient to indicate the specific problems.

In order to mitigate existing urban structure in Tehran, the following mitigation measures could be applied.

- Urban redevelopment
- Road and urban infrastructure improvement
- Area-based building reconstruction and retrofitting
- Individual building retrofitting and reconstruction

From the aspect of creating a more earthquake resistant urban structure, area-wide urban redevelopment projects are preferred in the context that they would accrue diverse benefits such as the improvement of urban environment and the value-added land use to enhance financial viability of the projects. However, the implementation of urban redevelopment projects should be supported by necessary institutional and legislative arrangements to enable the following systems.

- Public-Private-Partnership (PPP) system
- Dedicated fund for urban redevelopment
- Designation and legislation of "Special Urban Redevelopment Zones"
- Practical land readjustment and right conversion systems
- Financial cross-subsidization system
- Legal process for formulating consensus among residents
- Cadastre-based land registration and appropriate property assessment systems
- Taxation systems to capture accrued benefits from beneficiaries
- Enforcement of earthquake-resistant design codes and inspection system to secure design-compliant building acts

IDENTIFICATION OF SAFETY EVACUATION SPACE

The evacuation system is proposed as follows:

Regional Evacuation Place

It is an open space such as a large-scale park or green place having a space that is necessary to protect lives of evacuating persons from dangers such as spreading of fire or others that arise at the time of a large-scale earthquake.

Community Evacuation Place

It is a place for neighboring evacuating persons to temporarily assemble and to watch the situation before evacuating to the Regional Evacuation Place. It is a place for evacuating persons to form a group temporarily to evacuate to the Regional Evacuation Place. The place shall be such as urban parks, sports field, school, religious facility, etc. in which the safety of assembled persons can be secured.

Evacuation Route

In this study, regional evacuation place is identified from public space such as parks and open space. 136 candidates were identified. Primary evacuation place will be identified by each district.

Emergency road network has been identified in this study. Emergency road system is proposed as follows:

Primary Emergency Road, linking with Disaster Management Centers of national, provincial, municipality, district, and sub-district municipalities and major airport and seaport as for transportation nodes. In order to set-up the network, all of centers have to be clearly identified and categorized on the base map.

Secondary Emergency Road, Linking with all the identified emergency response centers of rescue/fire fighting/security, emergency road, and medical care. Also, all emergency response centers have to be clearly identified and categorized on the base map.

Tertiary Emergency Road, Linking with the identified centers of emergency foods, water, and goods storage and distribution.

STRENGTHENING EXISTING INFRASTRUCTURES AND LIFELINE

Bridges

The previous Microzoning study estimated six bridges as “Collapsed” and five bridges as “Unstable.” Compared with building damage in Tehran, bridge damage is relatively low. Most of those bridges are not yet reinforced or rebuilt. In order to reinforce the existing bridges, a detailed investigation of those bridges is required before any work is carried out. .

Water

The previous microzoning study showed the pipeline damage points. The damage analysis on other water supply facility has not been done. It is required to assess the vulnerability of the water supply facility and improve it according to the analysis results.

Gas

For the countermeasures for natural gas supply system, it is fundamental to arm each facility with enough seismic resistance, and to consider the characteristics of each facility. The previous microzoning study showed the damage analysis on gas pipeline but not on other related facilities. Based on the previous study results, Gas Company has carried out further vulnerability study on gas facility.

Electricity

Damage analysis on electrical power cable damage was done by the previous microzoning study. The other facilities should have been evaluated based on the assessment results.

PROVISION OF EARTHQUAKE INFORMATION AND EDUCATION

In order to be prepared for an earthquake and mitigate the damages from an earthquake, this plan establishes to increase the knowledge on disaster management and to implement drills to the local government staff and related organizations and also to disseminate the knowledge of disaster preparedness to local residents in various occasions and to try to increase their awareness and capacity of self-disaster-preparedness and responses continuously.

Education for government staff

The following items will be included as necessary information.

- Basic knowledge of earthquake
- Prediction of earthquake breakout in Tehran
- Results of the estimated damages and vulnerability of earthquake in Tehran
- Plan, laws and regulations related to earthquake in Tehran

Disaster -related Organization

- Causes of disaster outbreak
- 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 with and roles of related organizations
- The past disasters and issues for emergency responses, etc.

Education for School Students

Tehran Municipality and district offices will provide education with the following in mind:

To consider the contents of guidance and approaches based on the development levels of students, types of schools and location of schools, etc.

To utilize educational materials such as supplementary readers and audio-visual aids in accordance with students' development levels

To instruct "importance of life," "family ties," "mutual cooperation", etc. through implementation of learning by experience of nature life, welfare and voluntary activities, etc.

Education for the General Public

As knowledge of daily preparation for earthquake and what to do in case of earthquake, the following items will be enlightened:

Measures of disaster preparedness regulated by Tehran Municipality and district offices

Basic knowledge of earthquake and the past earthquake in Iran

Preparation before occurrence of earthquake and necessary items after occurrence of earthquake

Social Education

Knowledge of earthquake will be disseminated and enlightened through various seminars and trainings with some target groups (NGOs and CBOs) such as women's groups, environmental groups, youth association and PTA, etc., so that local residents can have consciousness as members of society and increase awareness of their contribution to local disaster preparedness.

ESTABLISHMENT OF INSURANCE SYSTEM

Iran government has regulated establishment of insurance system in Iran. Accordingly, the earthquake insurance will be developed in the direction of universal coverage of buildings and facility in Iran.

The following issues may form the foundation for further discussion and deliberations:

- 1- Insurance system concept
- 2- Regulatory framework
- 3- Incentive system
- 4- Development direction

Development insurance system may have the following alternatives:

- 1- Develop the insurance system and institution within the country and access to the international markets.
- 2- Provide the low rate of loan and subsidy to poor families to access to cheap mitigation measures. This arrangement reduces the costs of the earthquake damage and the costs of insurance.
- 3- Establish an insurance system which covers most of building in Tehran to transfer the risk from the housing loan.

ESTABLISHMENT OF COMMUNITY LEVEL DISASTER MANAGEMENT ORGANIZATION

Community-Based Activities for Disaster Preparedness

In order to protect life and property of the local people from earthquake damages, it is important for all disaster-related organizations at national to community levels to take measures as best as they could. At the same time, individual local resident has to get a concept of self-protection, have enough knowledge of earthquake, accumulate training, learn countermeasures of disaster by experience and implement these activities at home, in the community and workplaces, etc. Furthermore, these measures for disaster preparedness can be effective if the local community cooperate, 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 will indicate the standard and regulations for appropriate and effective activities for disaster preparedness.

Roles of Workplace

The role and contents to be implemented by industries and workplaces for local disaster management activities are described here. The persons who manage or operate the workplaces and facilities will protect and keep safe the employers and users and implement appropriate activities for disaster preparedness in order to prevent the area from expanding the disaster. Additionally, the workplaces will make efforts to participate in the activities for disaster preparedness such as rescue of the affected people as a member of the community. For this purpose, the workplaces will make groups of self-disaster-preparedness, contact with other groups of self-disaster-management in the related area and try to secure the safety of the workplaces and the related area actively.

Support and Guidance from Tehran Municipality

Tehran Municipality and district offices will promote involvement of the existing CBOs and NGOs and establishment of groups for self-disaster-management in Tehran and support for the vitalization of their activities. Areas to be considered with attention are areas (a) with high population density, (b) with many disaster weak, (c) with high vulnerability of housing and facilities, (d) with less collaboration among the residents, and (e) with shortage of water for fire extinguishing.

Community Level Organization

As to administrative level, there exists sub-district under district. Since mahale (Neighborhood Community) is not an administrative division, there is no formal links between district office and local residents. In considering the disaster preparedness and emergency responses, the bridge between district offices and individual local resident is indispensable.

The candidate places are:

- housing complex
- mahale council
- school
- office, factory and bazaar
- mosque
- cultural center
- health center
- sports center
- NGOs and CBOs
- Red Crescent Society
- Public participation center, etc.

These places can be a center for disseminating information and collecting people for training and seminars provided by district offices. And the people in these places will be able to respond to emergency as a group if they are provided with information and training. Since the social structure in Tehran is very complex and diversified, these networks should be combined accordingly for the purpose to cover all area of Tehran. However, in order to make all these bridges work well, they have to be provided education and training in advance and be ready and committed to act in emergency case.

PROTECT CITIZEN'S LIFE AFTER THE EVENT (EMERGENCY RESPONSE PLAN)

IMPROVEMENT OF EMERGENCY RESPONSE SYSTEM

Emergency Response Scenario

Ray Fault Model is taken as the scenario earthquake. However, the damage considered to be caused by the Ray Fault Model is extraordinarily huge and sometimes beyond imagination. Therefore, some description might not demonstrate the real situation.

Emergency response scenario of 1) Municipality Emergency Response Headquarters, 2) Rescue, Relief and Medical Treatment, 3) Evacuation, 4) Traffic and 5) Lifelines are assumed.

Legal Background of Emergency Response

According to the Act of the Constitution, the government of Iran regulate themselves to provide social security services for health and treatment services and medical care, etc. The governments should prepare emergency response plan and procedure to cope with the situations. At the national level, the Red Crescent Society of Iran has a responsibility for rescue and relief activities.

Organization and Management System

Organization

The Tehran Comprehensive Disaster Management Plan proposed the establishment of an emergency response organization based on Incident Command System (ICS), which is a model for command, planning and coordination after emergency.

Commanding system

The comprehensive disaster management plan proposed to have an ICS together with Standard Emergency Management System (SEMS).

Organization for Initial Action

According to the existing laws and regulations, the organization for the emergency response is shown as follows:

FORMULATION OF EMERGENCY RESPONSE PLAN

Information and Communication System

If the disaster and rescue network will be newly installed, all desirable functions will be equipped in this occasion.

Necessary Information in Disaster and Rescue Network

The necessary information is divided into two categories, one is for victims and public and the other is for rescue and relief operations.

The information is summarized in three.

- Information of next earthquake and fire as after shock
- Safety information of family, friends and relatives
- Detail earthquake information such as hypocenter and seismic intensity

While, the following information should be required for rescue and relief operations.

- Information of number of victims to be nursed in each area
- Road blockade information
- Notification of designated evacuation route and place
- Information of commodity supply such as water and food

Configuration of Disaster and Rescue Network

The backbone of the network is newly established with microwave system connected between Tehran Disaster Prevention and Mitigation Center (TDPMC) and 22 district buildings. TDPMC is a hub station, and all the necessary information are collected and analyzed, and sub-disaster management center is also provided for security reason.

The core network is very stable and has large capacities, so it is recommended to use the core network in routine works during office hours.

- New mobile radio system operated by TDPMC
- Satellite network with small terminal station
- GSM network as a part of public network

Radio LAN network and private PHS mobile system is also to be studied.

The most important role in the management center is to prepare the optimum formation for rescue and relief operations to meet the damage size judging from obtained daily observation data.

Search and Rescue

Resources for search and rescue operation in Tehran, is expected totally short to meet exploding needs after the earthquake. Given the circumstances, some important strategies to fulfill the overall objective will be to:

Move promptly based on the simplified command and coordination mechanism

Search and Rescue operation is commonly understood to be critically effective until 72 hours after the building destruction by the earthquake. Only simplified system to make decisions, which might be realized by uniting local Task Force Organizations with national organizations, can make it possible to mobilize the resources over the country and concentrate them on Tehran in the shortest time.

Utilize the community resources for disaster response to the fullest extent

It will be impossible to put Search & Rescue teams into countless collapsed buildings. Rescue operations will not reach the people in any other way but by counting on community people's help for the trapped in ruins of residential buildings with three or less stories.

Establish Mass Casualty Management as a part of systematic response

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.

Search and rescue teams

Search and rescue teams at three levels defined in table below will be deployed over the affected area. In principle, one District Rescue Team and ten Community Rescue Teams may be thrown in a district impartially, while two to three Hyper Rescue Teams, which are equipped with advanced search devices, will be dispatched to the highest priority facilities

Field Care

Casualties will be managed through the standardized in. It consists of four vital emergency elements: community- based response activity, AMPs at sites, Hospital care and Logistics. Among them one of key components is AMP, which will play a role of checking point before sending the injured to hospitals to control their flow.

Community-based Rescue and Treatment Activities

Rescue- and Relief- related players in community are categorized into two: One is Local authority, personnel and groups, and the other is Local Health Personnel (LHP). Community people will be organized and mobilized on voluntary basis to assist Community Authority and Local Health Personnel.

TDPMC and District Municipality.

When disaster has arisen or is about to arise and it is deemed necessary to protect human lives or bodies, District Municipality shall establish a warning area and restrict or prohibit the entry into such area and order to move-out from such area..

Even in an ordinary time, it is necessary for each area or community (residents association) to grasp the actual condition of the area in respect of forming a group or of self-governing situation at the time of evacuation.

Regional Firefighting Department

Firefighting Department shall recommend or instruct residents to evacuate when it judges that spreading of fire or diffusion of gas is rapid and that the danger to human lives is seriously imminent. On such occasion, it shall immediately notify the District Municipality.

Evacuation Guidance

The role and measure for the evacuation guidance in each organization shall be defined by respective agencies.

TDPMC and District Municipality

When recommendation or instruction is issued TDPMC shall quickly distribute the contents of recommendation or instruction by following measures:

- Announcement using speaker at mosques or schools
- Oral communication to residents or community leaders directly
- By utilizing mass media
- By utilizing publicity activity by Police Department or Fire Fighting

At the Community Evacuation Place, staff of the District Municipality shall formulate groups of respective areas, communities or companies by obtaining assistance of a Police Department and a Firefighting Department. After that, they shall organize a group leader of communities or persons in managerial position of companies and shall guide them to the Regional Evacuation Place. On such occasion, it shall cause persons who are vulnerable to disaster such as sick persons, senior citizens or disabled persons to evacuate on top priority

It shall allocate necessary number of guides at the Regional Evacuation Places. They engage in collection of information relating to damage and public relations activity and getting hold of missing people. They also shall take measures of re-evacuation when it judges dangerous and shall make efforts to keep the order at the evacuation place.

Firefighting Department

Firefighting Department shall notify TDPMC and the District Municipality about most safe route and directions of evacuation taking into account the size of disaster, situation of roads and bridges, diffusion route of fire and operation of fire fighting.

When evacuation begins, Firefighting Department shall engage in evacuation guidance by activities of firemen. Firefighting activity after the point when recommendation or instruction is issued shall endeavor to secure the safety of evacuation places and evacuation roads.

Traffic

Control from Space Aspect

Route Control

The route control covers road sector and route. Total prohibition or partial prohibition on traffic in which passage of vehicles other than designated ones are prohibited, is implemented. Designation of emergency road or emergency transportation routes falls under this category.

Area Control

The area control is to regulate the traffic, in a uniform manner, not only for disaster-affected areas but also surrounding areas. One can imagine possible cases in which it becomes impossible to go through roads because of collapse of structures along roads such as roads houses, buildings, power poles or fences and so on and road traffic function is paralyzed in the surrounding blocks of areas.

Control from Time Aspect

Detailed regulation by a unit of time is unrealistic in a state in which traffic is confused at the time of disaster, and rough regulation, which takes into account the actual situation of traffic in daytime or night time or on weekdays or weekend, is appropriate. However, it would be better to avoid, as much as possible, changing the regulation time depending on the traffic situation. The reason being that, if the regulation is changed frequently, it becomes difficult to make information concerning regulation fully understood, mistrust to the regulation arises and it is feared that the traffic situation becomes even unstable by contrast.

Traffic Enforcement and Provision of Information

Whether or not the traffic regulation can achieve its objectives largely depends on the implementation system of the traffic enforcement. If, although emergency transportation routes are proposed, number of entry point on crossing roads and areas along roads are enormous, it is quite difficult to restrict the inflow of ordinary vehicles only by means of

barrier, cone or allocation of police officers. And it can be well imagined that illegal parking or abandoned vehicles on emergency transportation roads cause traffic jam. Therefore, in order to enhance the effect of traffic regulation, it is necessary to provide information quickly by using any and all means.

Health and Medical Service Operation

Medical resources available in Tehran is expected totally short to cope with enormously surging needs after the earthquake. Given the circumstances, some important strategies to fulfill the overall objective will be:

To place first priority on life-saving care throughout the medical care operations

Treatments must be selectively provided to the injured that will be judged savable through triage at every treatment point.

To mobilize and utilize available resources fully regardless of locations, ownership and source

Government commitment is crucially important to mobilize private sector totally by endorsing monetary compensation for their expenses to treat the injured unconditionally.

To make systematic response by establishing treatment level tiered-system over the country

Establishment of system to provide care, from community first, then to transfer to hospitals in local network, and to hospitals in metropolitan and national network, is crucially important.

To provide health care to fit people needs which change over time

Health resources must shift from treatment for surgical cases during first several days to care for acute internal cases followed by patients with chronic diseases.

Lifeline

In Tehran Municipality, by initiation of TDPMC, each Sub-committee, including Water Committee, Natural Gas Committee, Power Committee, prepared a Standard Operation Plan for emergency response. Furthermore, based on the Standard Operation Plan, Greater Tehran Gas Company, and Tehran Regional Electric Company prepared a more detailed Emergency Response Plan. Especially, GTGC is revising their plan by reviewing the Emergency Response Plan, which covers all the necessary part of emergency response. It is necessary to prepare such a plan and each staff must be aware and well understand the purpose and importance of such a plan. According to the meeting with Tehran Water and Sewage Company, they have not prepared a detailed emergency response plan yet. Therefore, utilizing the information, it is necessary to prepare a detailed emergency response plan in the near future. In the later section, tentative emergency response plan is prepared for the reference.

Water Supply

Potable water is indispensable resource for human life. After the event of earthquake, it is easy to imagine that lack of water will be occurred and, therefore, establishment of emergency water supply plan in advance will be extremely important to avoid a disorderly situation.

It shows that after 11 days, people with access to water will be half of the population in Tehran, and after 21 days, no one will have access to water. However, as mentioned before, this figure assumes that no water transmission is supplied from dam and purification plants. It is hard to estimate all the transmission pipes will be damaged. Therefore, this is the worst case and it can be said that total volume stock of water by water reservoirs is comparatively large even if compared with other countries.

Foods Provision

The following measures are the necessary requirements for Tehran Municipality.

To provide storage facility for foods and primary living requirements in relevant institutions in each of municipal district.

Emergency response related institutions in each district such as district office, traffic police,

and military installations are preferable to provide storage facility, taking into account the capability of provisions to go through, which depends on the accessibility to emergency road network.

To make an agreement on foods provision with retailers and wholesalers

The emergency foods should be put in storage facilities at any time. However, given the limitation of storage capacity, emergency foods will be run out in the long disaster recovery term. The relevant institutions should have a contract with retailers and wholesalers for additional provision by order in the case of lack of foods.

To establish a cooperative setup and define the sphere of responsibility and roles with Red Crescent

For the effective foods provision in the event of disaster, the responsible areas to Red Crescent and Tehran Municipality should be clarified.

CONCLUSIONS

A Comprehensive Master Plan Study on Urban Seismic Disaster Prevention and Management for Tehran City was carried out based the recommendations of the seismic microzoning study. The study encompassed the issues such as urban disaster prevention plan, Earthquake resistant structure measures for buildings and infrastructures, Community development plan for disaster management, Preparation of earthquake disaster management plan, and Formulation of disaster management programs and projects. The planning approach of the study included Investigation of building structures, Importance of planning process, Community disaster management plan through people's participation, Preparation of earthquake disaster prevention and management plans, and Integrated approach for program and project formulation. The Study proceeded in 3 phases and achieved the following defined objectives:

- Comprehensive Diagnosis of Disaster Prevention and Management Situation in Tehran
- Preparation of the Master Plan for Urban Seismic Disaster Prevention and Management in Tehran
- Preparation of an Action Plan for the Implementation of Urgent Priority Projects and Programs

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