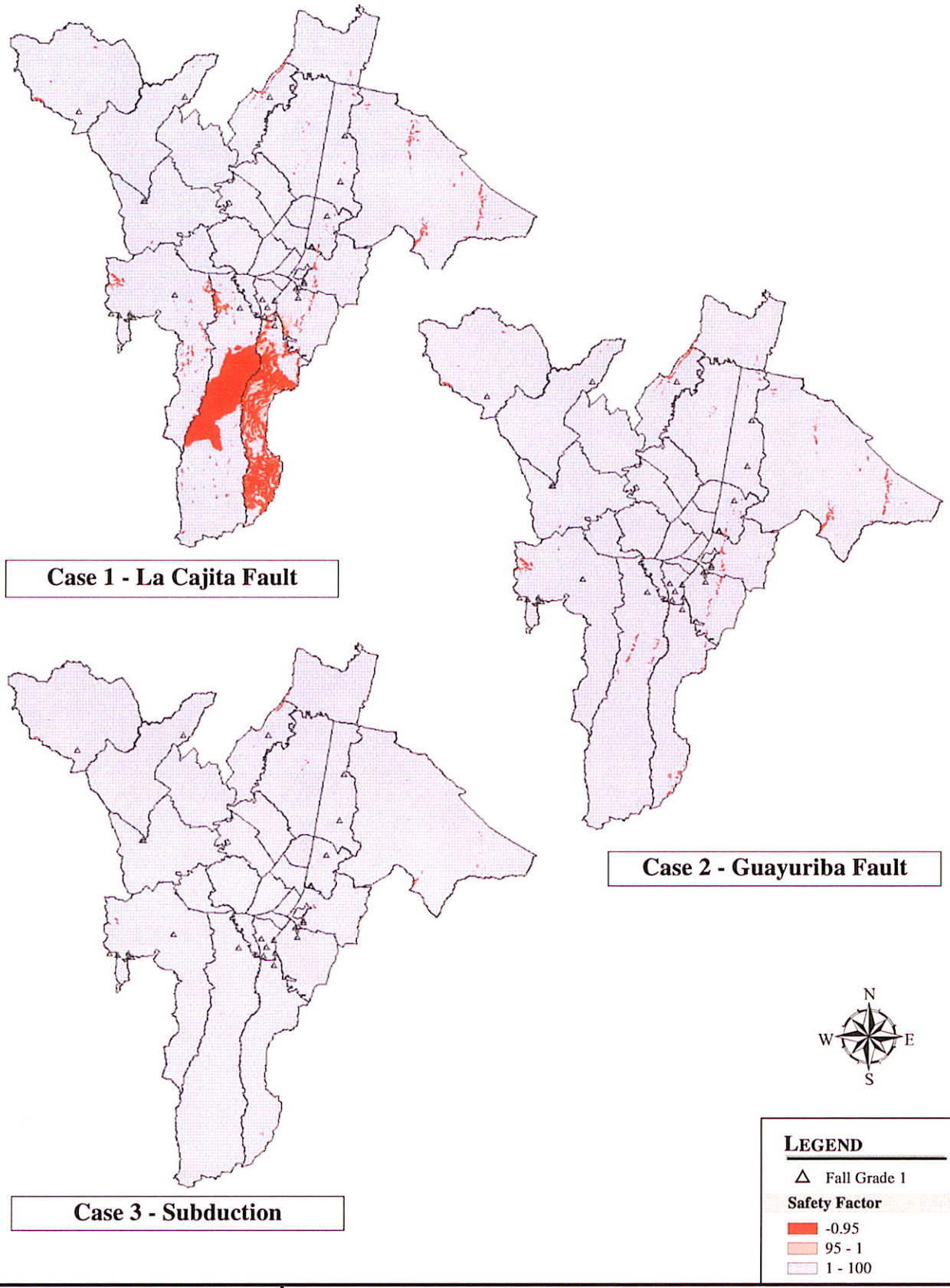

Appendix 4.2.13	Estimated Slope Stability During Earthquake (Fall)

APPENDIX 4.2.14

1. CHAIN REACTIONS DURING DISASTER

Disaster in modern urban area is a complex, time evolving process. Damage in one part will spread and affect another part, if not handled properly. Following are examples of chain reactions during disaster that originate in physical damage of urban infrastructures.

Building damage

Damage to buildings would not only cause human casualties, but also disrupt adjoining electricity or telephone lines. Collapsed buildings would close narrow streets so that traffic or rescue work or would be obstructed. Those who lost their houses will need shelters and space.

Heavily damaged buildings would require demolition works. Dust pollution during demolition work by asbestos used in construction materials will cause health problems such as cancer in the long run. Besides, dump for massive garbage from demolished buildings would be a problem.

Damage in water service

Suspension of water service would directly affect human lives that need a few litters of water a day. Shortage of clean water or contamination of water by pipeline damage will cause health problem. Besides, it also affects fire fighting, and emergency medical operations. Breakage of water pipelines would cause water leaks and fill broken gas pipelines with mud and water, which would require cleanup of gas pipeline during recovery work.

Damage in gas service

Leakage of gas would cause fire or explosion, and may require evacuation of residents. Gas leak would obstruct rescue operation as well. Leakage of electricity can be a trigger of fire. Such a case can happen not only immediate period after earthquake, but also during recovery process of electricity and gas in damaged area.

Damage in electricity service

It would affect pumping of water, telephone line, among other lifeline services, that do not have power backup system. Lack of electricity also would affect medical operations, and absence of light would lessen security in the night. The suspension of traffic signal would cause confusion in traffic control.

Damage in telephone service

Disruption of telephone line will suspend communication. Even if telephone line were not damaged, traffic in telephone service would be saturated after earthquake due to the concentration of calling. Under such situation, communication would be only possible via radio or satellite.

Damage in road

Road would be closed by collapsed building or bridges. Cracks in the road or landslide would also affect the road condition. Further, abandoned or damaged vehicles would be obstacles. Such situation would hinder transport of emergency vehicles such as rescue, fire fighting, and emergency supply from outside. It would also enhance traffic jams, and affect traffic of roads that do not suffer damage.

Damage in landslide

It would block roads and damage nearby housings. It would also block river so that dammed water may cause flooding, in case of heavy rains. Landslides could occur long after major earthquake, especially associated with heavy rain, because strong shaking by an earthquake or its aftershocks could lessen the slope stability.

Damage in industrial facilities

The damaged industrial facilities would cause fire, leak, or even explosion. In the worst case, evacuation of residents would be necessary.

APPENDIX 4.2.15

1. LESSONS AND RECOMMENDATIONS IN DISASTER ATTENTIONS

Lessons from earthquakes in recent earthquake in Kobe and in Armenia are described according to the different stages in disaster attentions. Some recommendations are made.

1.1 Pre disaster stage

Risk perception of people in general against disaster

In western part of Japan, people in general had believed that earthquakes do not occur in the region, due to the less frequent activities in recent years compared to other regions. Kobe city did have seismic risk study, but expected magnitude for scenario earthquake was set at lower value.

The map of active fault in Japan that indicates existence of active fault near Kobe had been published, however, that map was little known to the public in general. Such low risk perception led to poor preparedness against earthquake disaster in that region.

The earthquake scenario should be made public in order to promote risk perception among public, and to make effective countermeasure plan.

Earthquake disaster in modern urban area

In Japan, the last experience of major earthquake disaster in urban area was Kanto earthquake in Tokyo in 1923. Throughout the period of rapid economic growth after Second World War, Japan has not suffered major earthquake disaster in modern urban area.

Earthquake disaster in a modern and major urban area would pose a complex situation. Its impact would not be limited in structural damage, but it would also affect social, economic aspects. The complete recovery and reconstruction would take at least several years after disaster.

1.2 Emergency stage

1.2.1 Direct attention

Administrative system in disaster management

In Japan, local government should handle disaster management in principle. The "national headquarter of disaster countermeasures" as defined by "basic law on disaster prevention" was established after four hours. However, "national headquarter of emergency countermeasures", that is not defined in the basic law, was then established

after three days. Its aim was to make more effective headquarter involving cabinet members. Rapid establishment of headquarter, with unified and substantial command is very important at the initial stage of disaster.

Assembly of emergency attention staffs

In Kobe city, 41 % of staffs came on the first day, and about 20% of stuffs came to office in Hyogo prefecture government after eight hours. Emergency power generator in City hall did exist, but it did not work because knowledgeable technical staff was absent.

Emergency attention staffs themselves could also be victims under major disaster, and in case staff with sufficient knowledge is lacking, emergency system does not work. For this reason, emergency staffs in some local government in Japan are given housing nearby the office, or 24 hours work shift system is held.

Initial damage information

The seismic intensity at Kobe had not been reported for the first thirty minutes due to the disruption of communication of network. This situation also contributed to the delayed emergency attention at emergency stage.

From this lesson, nation wide program of dense accelerograhs installation was executed in Japan, and satellite communication was put to use for accelerographs network.

Helicopters can be useful way to assess damage in wide area at emergency stage. In Los Angels, during Northridge earthquake in 1994, helicopter survey immediately after earthquake was very helpful. This was made possible because helicopter survey was routinely done by 24 hours shift for security reasons, important sites to be checked are listed in the survey manuals, and ground support was available.

Request for help

In Japan, official procedures of asking help from national government requires the request from damaged government. However, most severely damaged area cannot even ask help outside promptly. Legal framework that allows voluntarily help from outside without request in case of emergency would be necessary.

Safety of public buildings

Many public buildings such as fire stations, police stations, hospitals, city hall severely damaged or collapsed during earthquake in Kobe. Even if the building survived, inside of office was in disorder due to the strong shaking, thus the public office had to be firstly cleaned up to start work.

The office that stores basic database of infrastructure also had been damaged, thus basic database had to be reconstructed from another office. Such situation inevitably hindered prompt and effective attention and repair works.

Survival of key public building during earthquake should be important for emergency attention, and they should be put priority in seismic reinforcement.

Priority of tasks

After emergency, request of attention for every aspect will rush to emergency attention office. Moreover, staff will be busy to respond the requests of mass media. The priority of tasks should be made, depending on the urgency and importance.

Search and rescue works

Number of damaged buildings and human casualty will be much more than those in normal situation. Official rescue teams, equipped to work for normal situation, cannot necessary attend all of the work under such situation, in a short time. In fact, the neighbors contributed many of rescue works during earthquake in Kobe, with limited rescue tools. Such rescue did work well in communities where neighbors know each other well. The experience in Kobe demonstrates that noise from demolition work, or from hovering helicopters obstructed search and rescue work, which needs tranquility to detect signals from buried victims under debris.

First 72 hours is the most critical period for rescue operation for saving lives, because the possibility of saving lives drastically diminishes after that period. Stock of rescue tools would be necessary in communities, so that residents can use it in case of emergency. Rescue operation often requires heavy machines, so that their rapid procurement would be necessary. Besides, coordination of rescue work would be necessary.

Emergency medical operation

The main difference in medical operation under emergency are simultaneous large number of patients, and many of which are rescued suffer so called crash syndrome. Not all of medical staffs are familiar with such situation. Thus training of medicals for triage, which puts the priority of attention of victims to save lives as many as possible, and treatment of crash syndrome would be necessary.

Major obstacle to emergency medical operation in Kobe was lack of water and electricity. Power generator, water, and medicines should be kept in important hospitals. Besides, communication among hospitals would also be important.

Avoiding secondary disaster

Aftershocks will follow after major earthquake. Secondary disasters as described below should be taken into consideration.

- Human casualty due to collapse of damaged building.
- Landslides triggered by aftershocks and rain.
- Floods by dam up of river due to landslides.

Quindio River was reported to be dammed up, and people living in shores were at risk on fifth day.

- Leaks of chemical materials from damaged industrial facilities, and fire.

There was a report of explosion by chemical products in Pereira on first day.

1.2.2 Urgent attention

Emergency stocks

Emergency supply of water and food was not available for the first three days after major earthquake, until organized aid started. The emergency stocks for that period should be reserved.

Traffic control

After major earthquake, road will be obstructed by collapsed building or bridges abandoned vehicles, landslides, cracks in the road. Moreover, lack of traffic light will lose control, and police who will be busy for attending security matters will not fully control the traffic under such situation.

The traffic under emergency should be controlled to the priority vehicles, such as rescue, firefighting, or ambulances. The priority route should be defined, and if main road is closed, detour route should be indicated.

Social stability

Rumor would be easily spread under emergency condition, when situation is confusing, and people are very nervous and anxious about any information. In Japan, a mere precaution notice to aftershock was misunderstood as prediction of next major earthquake, and caused panic.

In Armenia, looting started in the second day in downtown. Bands of vandals arrived from outside in the second day. Many firemen left Armenia on sixth day, because looting and vandalism against their equipments was immense.

1.2.3 Emergent attention

Safety inspection of buildings

Safety inspection on damaged building should be performed, with the help of engineers. Since there would be so many buildings to be inspected after major earthquake, volunteers of engineers or students would be necessary.

The items and methodology of evaluation, and training of inspector should be prepared beforehand. The responsibility of evaluation and the way to use the result should be clarified. The safety evaluation may be expressed as ”safe”, “limited entry”, or “dangerous”. Buildings that are evaluated as “limited entry” would require detailed inspection later on.

Sanitary problems

Number of dead will also be much more than that in usual time. Sanitary care will be a problem to avoid epidemic diseases, when clean water is lacking. Human waste disposal shall be a big problem, in case sewage or water system is not functioning. Portable or temporary toilet would be necessary.

In Armenia, garbage collection had been suspended in the first week, and appearing of rats is reported in the second week. The spreading of lime over the debris started in second week. Fumigation also began in temporal shelters, and sanitary authority executed massive vaccination to prevent epidemic.

Fiber used in tiles of asbestos cements caused health problems during demolition works in Armenia. Same problem is also reported in Kobe, when demolishing damaged old buildings containing asbestos, which would cause cancer in the long run. In demolition works, effect of dust or asbestos on health of workers and residents should be taken care of.

1.3 Response stage

1.3.1 Recovery attention

Shelters

In Kobe, relocation of victims was done separately, and mutual help system among existing community had been lost. This caused isolation, and caused serious social problems later on. In case habitants are relocated to shelters, integration or function of mutual help within community should be kept.

Mental and psychological treatment

Those who have survived the disaster would have mental or psychological problems with experience of losing families or friends. Also, rescue workers who worked under severe condition also needed such care.

Such situation would emerge after immediate danger diminishes, but lasts for a long period if not treated properly. Psychological cares for survivors should be taken care of.

Public assistance information system

Various type of information will be required in the response phase. These can be provided not only by mass media, but also by community based paper media, or by Internet. The media should be carefully selected in order to facilitate to transmit information listed below.

- Name of dead or missing persons,
- Status of damage
- Reception of damage report and registration of victims
- List of shelters and provided services
- Available assistance and its application method
- Recovery status and plans for public facilities and lifeline services
- Aftershock information

Organizing volunteers

Many volunteers would join aid activities in damaged area, but they would cause confusion if not properly organized.

To work with the volunteers efficiently, they should be registered with the information of area of activity, and properly allocated among damaged area.

1.3.2 Social mitigation attention

Reconstruction planning

To establish a master plan of reconstruction, detailed study of damage should be done. In Japan, new constructions in damaged area can be restricted by law, while establishment of reconstruction master plan is underway. Some local governments have reconstruction plan prior to the major earthquake, based on the results of damage estimation study. This is because after experiencing the disaster, it would be difficult to concentrate to draw a master plan, and detailed damage estimation enables quantitative evaluation.

Attention to victims

Victims would need various assistances from different sectors in government, such as exemption or reduction of tax or medical fees, application of financial support or relocation of housing, etc. In order to provide such services in simplified process, victims should be registered in database, and history of assistance received should be recorded.

Improvement of disaster preparedness

Detailed study on damage and its recovery process should be made to record the status and learn lessons by engineering communities, research institutes, and administration. The recovery should not only aim to recover but also improve the preparedness for next possible disaster. Improvement of seismic code, regulations, guidelines, and laws shall be made with the result of detailed study.