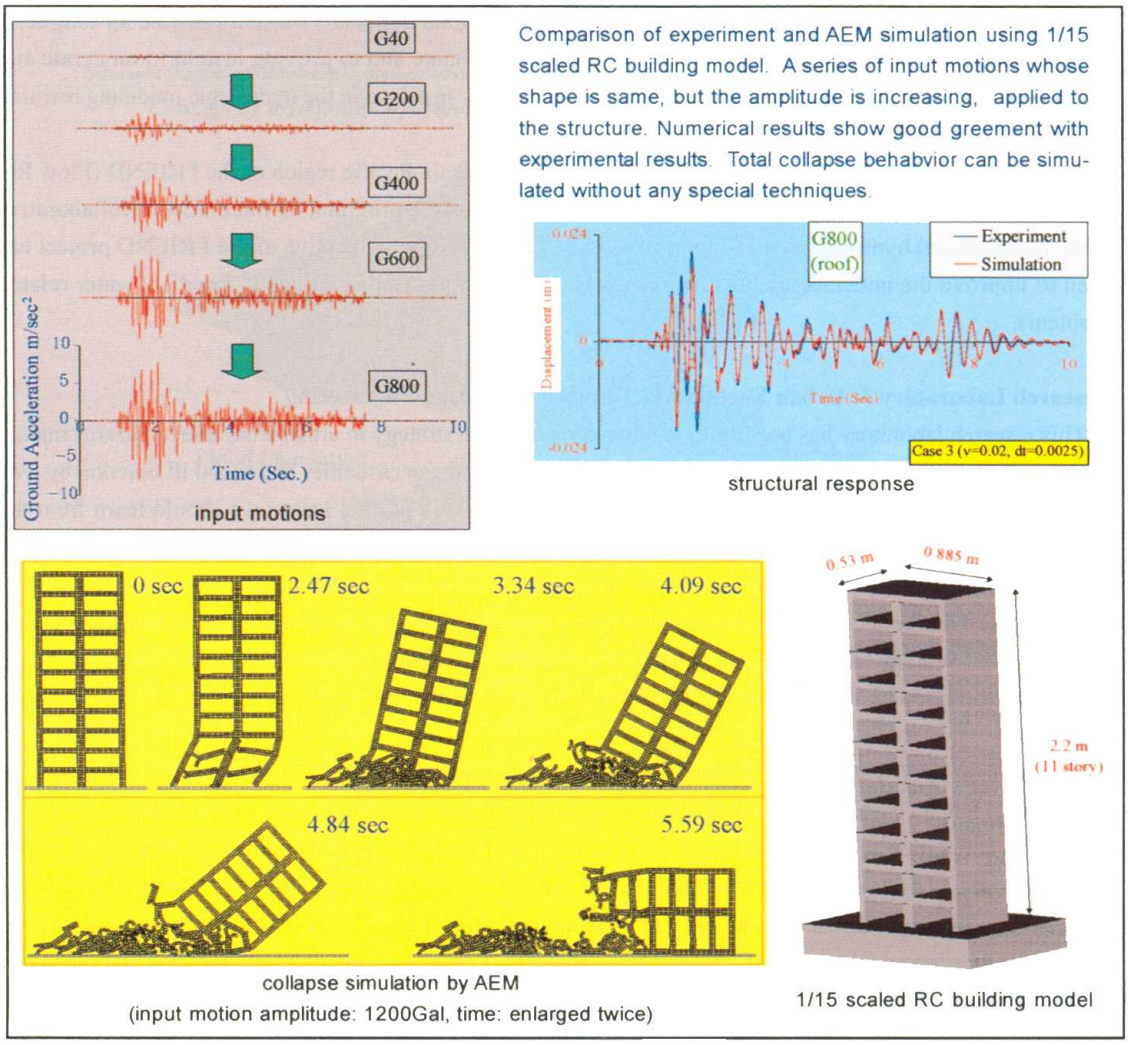
ii) Urban Space Design and Safety Evaluation from the Viewpoint of Evacuation Behavior of Users

Issues on structural behavior and/or physical strength of the structures have been main topic in construction of safe urban facilities. With the improvement of engineering technologies and construction materials, strength of the structures, especially in developed countries, has been getting better and better. (Of course, still, we have big problems on pre-code revision structures.) However, to build really safe urban spaces, it is very important to pay attention to the human evacuation behavior as well as structural problems[12]. Especially, when users aren't familiar with the space, its importance becomes much higher. Therefore, the space plan of urban facilities should be designed with proper consideration of users' evacuation safety and efficient evacuation guidance should be provided. To discuss the human behavior, we developed a new computer simulation model in which human evacuation behavior of a lot of evacuees in huge-sized facility or space can be easily simulated and

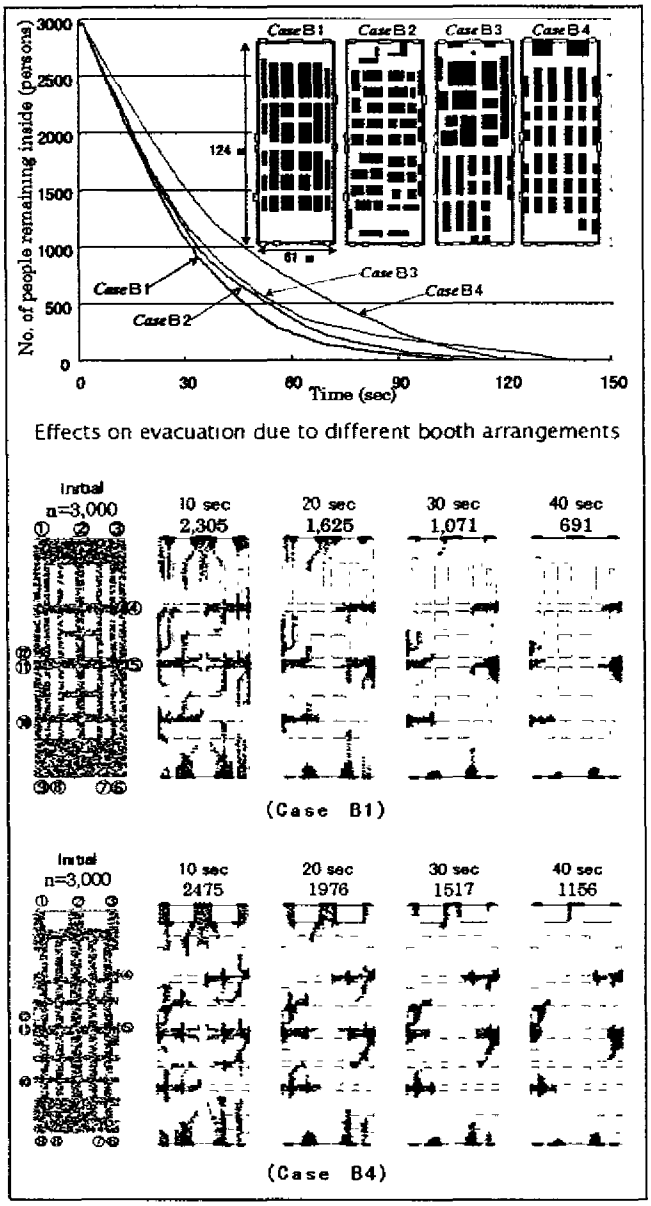


Applied Element Method: a newly developed model to simulate collapse process of structures accurately with reasonable CPU time

situation in disaster and individual personal characteristics of every evacuee can also be considered. In this study, we propose a new philosophy of designing structures, in which urban spaces are designed from the viewpoint of safety of users considering their evacuation behavior. When we apply the proposed model to any existing space, the safety of the space can be evaluated from the viewpoint of human behavior, and also, optimum evacuation guidance can be discussed based on the computer simulation of human evacuation.

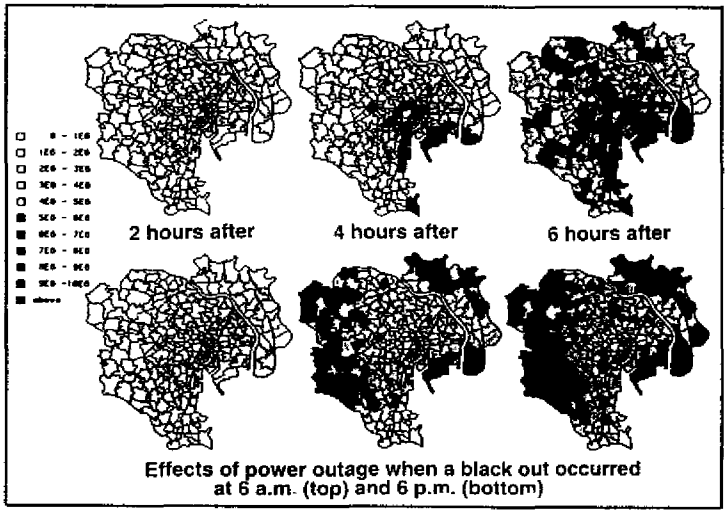
iii) Disaster Mitigation Countermeasures for Lifeline Systems in Urban Areas

Impact to the society due to damage to lifeline systems by a hazard like an earthquake or a typhoon is studied. Especially, taking the electric power whose ill function affects the other life line systems and also many social functions, we have proposed the method for quantitative evaluation of power outage considering regional characteristics, occurrence time and duration of outage[13]. Based on the results, we have also proposed a method for proper counter measures against blackout.



Effects on evacuation due to different booth arrangements

Simulation of Human Evacuation Behavior:
We discuss the effects of arrangement of booth in exhibition hall on human evacuation behavior. Each dot represents a person trying to evacuate frominside an exhibition hall. The value of 'n' is the total number of people remaining inside the hall



Effects of power outage when a black out occurred at 6 a.m. (top) and 6 p.m. (bottom)

Estimation of Effects due to Power Outage in Urban Area foe Optimum Measures:
Our modern societies heavily rely on electric power and suffer functional damage due to power outage when natural disasters such as earthquakes and typhoons strike. To develop a new methodology for estimating the effects of power outage on city functions considering the characteristics of the area, occurrence time and duration of outage, a database is developed which consists of regional characteristics and electric power demand in Tokyo using geographic information system Using the database, a new methodology to estimate the effects of power outage is proposed which can be used for optimum disaster mitigation measures before and after an accident.

From the experiences of the 1995 Kobe earthquake disaster, we have been discussing the optimum recovery/ reconstruction strategy of lifeline systems considering interactions between their activities. Because we observed many interactions between different lifeline systems which hindered the recovery activities of each other. Each of the organization or company did its best to recover the its own services, however, from the viewpoint of whole lifeline systems, it was not the best way. We can modify the recovery/reconstruction procedures for getting global maximum. This is a main concept of this study.

4-1-2 Collaborative Research

For international cooperation, INCEDE has been collaborating with different research organizations and researchers around the world for carrying out meaningful and productive research works in regional or global level. In such collaborative works with foreign researchers, three laboratories of INCEDE work together toward creating a multidisciplinary research environment for complex problems of disaster mitigation In addition to this joint collaboration, three laboratories individually coordinate research projects with different national and international organizations on specific research topics of interest. Out of the various collaborative projects that INCEDE has been conducting, three major projects are listed below;

Flood Forecasting Modeling in the Philippines

This was a three-year joint research project from 1994 to 1996 on flood forecasting and warning systems between INCEDE and the research institutions in the Philippines. The counterparts in the Philippines were the Philippine Atmospheric, Geophysical and Astronomical Services Administration (PAGASA), the National Hydraulic Research Center (NHRC) of the University of Philippines, and the National Mapping & Resource Information Authority (NAMRIA). Ministry of Education, Culture, and Sports of Japan supported the project. In this project, an extensive GIS data base of the Agno River basin of the Philippines and a flood forecasting model for the Agno River were developed.

Post-earthquake Reconstruction Strategy

This project was a Center-to-Center Project between INCEDE and National Center for Earthquake Engineering Research (NCEER, later changed to MCEER- Multi Disciplinary Center for Earthquake Engineering Research), State University of New York, Buffalo on post-earthquake reconstruction and rehabilitation strategy. The Japan Society for Promotion of Science (JSPS) and the US National Science Foundation (NSF) jointly supported the project. The three-year project was initiated in October 1995 and ended in September 1998. The main objectives of this joint project were,

- to carry out a comprehensive comparative study of recent earthquake experiences in Northridge (USA) and Kobe (Japan) in order to identify generic issues for post-disaster reconstruction.
- to conduct case studies and to identify exemplary technical, societal and financial strategies for the retrofitting and post-earthquake repair and restoration of the built environment in an optimal fashion.
- to carry out individual disciplinary-oriented research to fill knowledge gaps and simultaneously, to formulate one or more strategies for recovery using a system-integrated team approach involving multi-disciplinary experts.
- to exchange visiting researchers and students and to share experiences to enhance the spirit and substance of IDNDR

- to encourage and facilitate additional cooperative research efforts among earthquake engineers in Japan and US and to establish further joint efforts with other centers/research groups in both countries.

Under this project, six technical workshops were held among the researchers and practitioners from Japan and USA. The project had two valuable products as the outcome of the three-year joint research. First is a series of technical reports, which have documented the outcomes of various research activities of the participant researchers on Northridge and Kobe earthquakes. The second product was a digital source book, which includes lessons learnt from Northridge and Kobe earthquakes for an effective countermeasure for the recovery due to an earthquake, which can strike not only Japan or USA but, any urbanized area in the world in the future.

RADIUS Project

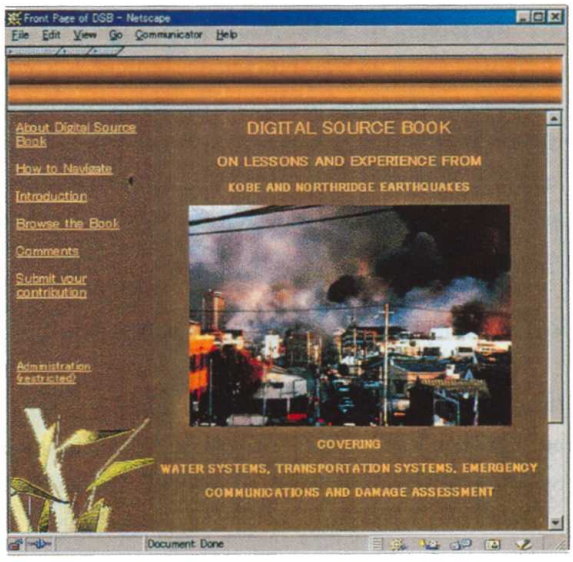
This is an on-going project started as the initiative of IDNDR Secretariat. Looking at the growing risk of earthquakes, the IDNDR Secretariat of the United Nations, launched the RADIUS project (Risk Assessment

DR. Pineda of PAGASA shows receiving of telemetric gauging stations datato INCEDE team

Philippine researchers survey river protection works, Japan

First US-Japan meeting on C-to-C project at INCEDE, December, 1995

RADIUS project workshop in Tashkent, 1997



Front page of the Digital Source Book (DSB) browsed in WWW through dynamic interaction with oracle database

Tools for Diagnosis of Urban Areas against Seismic Disasters) with assistance of the Japanese Government to promote worldwide activities for reduction of earthquake disasters in urban areas, particularly in developing countries. The project aims at developing practical tools for seismic risk assessment of the urban areas based on the analysis of case studies. The case studies are to prepare earthquake damage scenarios in several cities around the world with the financial support and technical assistance from the IDNDR Secretariat. These practical tools will be developed for seismic risk assessment of the urban areas, in order to raise the awareness of decision makers, government officials, business leaders, communities and citizens of the importance of disaster mitigation measures and to provide them with directions for disaster mitigation. Through the project, it is expected that state-of-the-art studies and technologies for seismic disaster mitigation will be incorporated into appropriate tools available to the whole world. These tools will be developed based on the analysis of case studies, which will be carried out in nine cities around the world.

The IDNDR Secretariat selected 9 case study cities, to which the IDNDR Secretariat offer technical and financial assistance. The case studies have started in February 1998 and will end in July, 1999. INCEDE is one of the three international institutes that IDNDR Secretariat has selected to participate in the project. INCEDE is responsible for conducting case studies in Asian cities.

INCEDE has been observing, since its inception of 1991, that it is difficult for many disaster prone countries to divert large amount of resources to disaster reduction measures. However, through INCEDE Networking activities, we have made an observation that a very few money allocation to disaster measures could function efficiently in disaster reduction, if all resources available are fully brought together. INCEDE thinks that the RADIUS project is a good and timely opportunity to demonstrate disaster prone countries/cities this fact. Actually, all the case-study cities are such cities mentioned above. INCEDE is convinced that successful case studies in these cities will encourage rest of earthquake prone cities to take actions and stimulate. International donor agencies will be encouraged, as well.

4-2 Reinforcing the network of disaster related communities

Disasters have no boundaries, a major disaster in a region can cover many countries. Many issues of disaster mitigation are common to all countries around the world and often a country alone can not fight against a major disaster with limited resources. To strengthen our ability to flight against disaster, a strong global network among disaster related communities are utmost important. From the very beginning, INCEDE realized this fact and has dedicated its time and effort in reinforcing the network of disaster related global communities through various activities as follows;

4-2-1 Development of INCEDE Network[14]

INCEDE has been developing a network called the INCEDE Network composed of disaster-related persons and organizations in the world. Major reasons for development of INCEDE Network composed of researchers and practitioners in disaster reduction are written in the righthand side table.

Many researchers working in the area of disaster in developing countries face the problem of acquiring enough

Major reasons for development of INCEDE Network

- *To preserve the important information on disasters (Knowledge of specialists),*
- *For useful assistance from outside,*
- *To record disaster information in the world (Disaster struck countries sometimes cannot afford to record the information)*
- *To share methodologies and experiences*
- *For better damage investigation taking care of the damaged sites, and*
- *To establish and maintain the good cooperation structure, etc.*

information on both the occurrence of disasters all over the world and, especially, new knowledge of the recent research activities in the field. Therefore, INCEDE Network has caught much attention.

We consider the activities related to the formation of the INCEDE Network to be of utmost importance, because the interaction between information generators and users/receivers must be two-way. The INCEDE Network was established so that all the members can be the generators as well as the receivers of information. Recently we have been hearing from our members on the disasters that had taken place in their regions, opinions and evaluations of mitigation activities. In compiling disaster-related information, various sources are available. On-line news services provide access to news wires from sources such as Reuters, AP, UPI, etc., and reports prepared by UN organizations such as DHA. It is often found that there are conflicting statistics depending on the sources and the timing of these summary reports. One very important expectation we have of network members is to clarify these conflicting reports and authenticate information, so that a reliable archive of disaster related information can be constructed and maintained.

At present, there are about 1,000 members of the INCEDE Network representing 100 countries. Including the network members, we also have a contact list of over 3,000 disaster-related persons and organizations from 150 countries. Any interested person can become a network member by filling up a form sent available INCEDE Newsletter or the on-line form in WWW INCEDE Home page (http://incede.iis.u-tokyo.ac.jp). The network members are obliged to be information providers as well as receivers, to receive help from other members in investigating a particular topic related to disasters as well as help another network member in his/her study related to the member's region or field.

4-2-2 Exchanging MOU with Institutes

INCEDE exchanges Memorandum of Understanding (MOU) with different organizations and institutes of similar research and work interest around the world to reinforce bilateral relationship in carrying out various research work in collaboration and sharing information. So far, INCEDE has exchanged MOU with eight institutes in four countries and one international organization as listed in the table below. Also, INCEDE is the process of exchanging MOU with the Asian Center for Research on Remote Sensing (ACRoRS) located at the Asian Institute of Technology (AIT), Bangkok, Thailand.

4-2-3 Joint Projects

Joint projects with organizations of different countries are another policy of INCEDE towards establishing strong international network. During the last 8-year period, it has established many collaborative projects ranging from fundamental research to practical implementation of available tools for disaster reduction with various organizations around the world, especially, with the institutes that it has exchanged MOU. Some of the major research projects of this kind are already mentioned in the section 'Collaborative research'. Another very important joint research

International Institutes having MOU with INCEDE

- *California Universities for Research in Earthquake Engineering (CUREe), USA, 1992.12.22*
- *National Center for Earthquake Engineering Research (NCEER), USA, 1993.2.22*
- *Department of Civil Engineering, Stanford University, USA, 1993 9 9*
- *Philippine Atmospheric Geophysical and Astronomical Services Administration (PAGASA), Philippines, 1994 2.9*
- *National Hydraulic Research Center (NHRC), University of Philippines, Philippines, 1994.3.30*
- *The Kamchatka Center of Earthquake Engineering and Natural Disaster Mitigation, Russia, 1994.6 2*
- *Venezuelan Foundation for Seismological Research (FUNVISIS), Venezuela, 1996 6.13*
- *United Nations University (UNU), Tokyo, 1996 11 22*