REGIONAL DEVELOPMENT

FOR

EARTHQUAKE DISASTER PREVENTION

Report and Summary of Proceedings of
the Second International Research and Training Seminar
on Regional Development Planning

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FOREWORD

Every nation in the world suffers directly from the damage resulting from recurrent natural disasters. The consequences of these natural catastrophes are sometimes very serious, especially in densely inhabited areas. In developing countries, the responses to disasters have been focused exclusively on relief actions following the occurrence of . disasters, but it is now time to adopt, more positively, planning for disaster prevention and mitigation. There are increasing concerns, among policymakers and persons in charge of regional development, that measures for disaster prevention and mitigation should receive greater emphasis.

In these conditions, recommendations on the need for information exchange, increased research and training on disaster prevention and mitigation, together with the need for their strategic implementation were adopted at the International Seminar on Regional Development Planning for Disaster Prevention, held by the united Nations Centre for Regional Development (UNCRD), Nagoya, Japan, in 1986. The importance of information exchange regarding disaster prevention and mitigation and the need for training relevant personnel was underlined in an action plan drawn up for the International Decade for Natural Disaster Reduction (IDNDR), which is to commence in 1990. Since 1985, when UNCRD began its project on regional development planning for disaster prevention, the Centre has worked actively for the successful implementation of these recommendations.

Following the abovementioned seminar, UNCRD held two International Research and Training Seminars on Regional Development Planning for Disaster Prevention in 1987 and 1988 respectively. The first seminar was held in October 1987, in Tokyo and Nagoya. Japan, in collaboration with the national government of Japan. The seminar consisted of the Expert Group Meeting held in Tokyo, and the Training seminar held in Nagoya. The main objectives of the seminar were to: Investigate ways, at the Expert Group Meeting, to strengthen the resiliency of communities in developing countries through the integration of pre-, mid-, and postdisaster measures in regional development planning; and set guidelines, at the Training Seminar, to compile curricula and teaching materials for organizing UNCRD'S coming training courses.

The Second International Research and Training Seminar on Regional Development Planning for Disaster Prevention was held in July 1988, in Nagoya and Shimizu, Japan, cosponsored by the Institute for Social Safety Science (1SSS). Japan, and the Earthquake Engineering Research Institute (EERI), U.S.A. The seminar in Shimizu consisted of six workshops during which the following themes were discussed: Policy problems of earthquake prediction; public and private awareness; estimation of earthquake vulnerability/damage; fire and hazardous materials following earthquakes; short-term emergency response; and long-term recovery/reconstruction. The output from the presentation and discussion at the Second Seminar is summarized in this seminar report. Chapter 2 of the report consists of each working group's summary of proceedings, which were summarized by each chairman of working group, using from the "Proceedings of the 2nd Japan-United States Workshop of Urban Earthquake Hazards Reduction" published by ISSS, EERl, and UNCRD.

The success of the seminar was due to numerous people who helped to make the Seminar a reality. Our heartfelt thanks go to those who contributed both in preparation of and during the Seminar, especially to those from ISSS, EER1 and Tokai University, to all invited experts who presented their papers and comments, asked questions, and cooperated in the Seminar, i.e., the speakers and discussants at each session, to chairmen who coordinated sessions concerned and summarized the session reports, and to all participants. We look forward to their continued collaboration in the years to come, especially during the IDNDR commencing from 1990.

28 February 1990

Hidehiko Sazanami
Director, UNCRD

CONTENTS

1. INTRODUCTION

BACKGROUND

In response to the growing concern and interest on the part of policy-makers and planners in regional development planning for disaster prevention, UNCRD organized an International Seminar in 1986. On the basis of the conclusions and recommendations of the Seminar, UNCRD is organizing a follow up research and training seminar annually to contribute to developing the human resources needed for shaping and implementing regional development planning for disaster prevention. The first International Research and Training Seminar on Regional Development Planning for Disaster Prevention was held in 1987 and gave the participants the chance to exchange ideas on regional development planning for disaster prevention from the viewpoint of a strategic framework such as pre-disaster, mid-disaster, and postdisaster measures at the Expert Group Meeting in Tokyo, and to exchange ideas and draw up guidelines for programmes on training courses for disaster prevention at the Training Seminar in Nagoya. Following the first Seminar, the Second International Research and Training Seminar on Regional Development Planning for Disaster Prevention which has the same objectives focused on earthquake disasters also intended to strengthen the resilience of communities from natural disasters and create safe residential environments in developing countries. It is expected that the knowledge gained through research and training seminars can be used widely to charter policies and train manpower in charge of disaster prevention activities.

OBJECTIVES

The main objectives of this Seminar are to investigate the ways in which one can strengthen communities in their resilience to natural disasters and create safe residential environments in developing countries from the viewpoint of measures to be taken within a strategic framework as integral parts of regional development planning. These measures can be classified into pre-disaster measures for prevention and mitigation; mid-disaster measures for emergency systems; and postdisaster measures for rehabilitation and reconstruction.

MAIN THEMES

The issues under the following themes, with special emphasis on earthquake disasters, were discussed at the Seminar:

(1) Preparedness Planning and Management as pre-disaster measures

Considering the present condition of disaster preparedness planning and management, issues and problems of disaster preparedness will be classified and strategies for the future will be investigated.

ISSUE l: Policy Problems of Earthquake Prediction
ISSUE 2: Public and Private Awareness
ISSUE 3: Estimation of Earthquake Vulnerability/Damage

(2) Emergency Planning and Management as mid-disaster measures

Considering case studies of disasters experienced
and problems of emergency planning and management
and strategies for the future will be investigated.

ISSUE 4: Fire and Hazardous Materials Following Earthquakes
ISSUE 5: Short-Term Emergency Response

(3) Rehabilitation and Reconstruction as postdisaster measures

Considering the economic and social impacts of rehabilitation and reconstruetion, it is hoped to investigate what postdisaster measures can be taken from the viewpoint of regional development planning.

ISSUE 6: Longer Term Recovery/ Reconstruction

COLLABORATION

This Seminar was coorganized by the United Nations Centre for Regional Development, the Institute of Social Safety Science (Japan), and the Earthquake Engineering Research Institute (US) in collaboration with the National Science Foundation (US), national and local governments of Japan, and other organizations. National and local government organizations of Japan are as follows: National Land Agency; Saitama Prefectural Government; Chiba Prefectural Government; Tokyo Metropolitan Government; Kanagawa Prefectural Government; Shizuoka Prefectural Government; Yokohama Municipal Government; Kawasaki Municipal Government; and Shimizu Municipal Government. The other cooperating organizations included Fire and Marine Insurance Rating Association and Tokai University.

This Seminar was well attended, with thirty-eight participants from the US, fourteen participants from developing and developed countries (Brazil, China, Ecuador. Egypt, Federal Republic of Germany, India, Indonesia, Iran, Mexico, Peru, Philippines, Thailand, and Yugoslavia), and 101 participants from Japan.

2. SUMMARY OF PROCEEDINGS

2-1 WORKING GROUP 1: POLICY PROBLEMS OF EARTHQUAKE PREDICTION

INTRODUCTION

An objective of the US-Japan Workshop on Urban Earthquake Hazards Reduction was to address policy problems in earthquake prediction. It is fortunate that such problems are being addressed now rather than later. Many of these problems relate directly to the actual scientific pursuit of an earthquake prediction capability. There is sometimes a tendency to separate the scientific aspects of earthquake prediction from the political, but it is neither practical nor advisable to do so. There are very serious public policy implications inherent in the scientific capability to predict a potentially damaging earthquake. If an earthquake prediction results from scientific endeavours, then the capability to manage the societal consequences, so that a desirable response is achieved, must also be in place. It is too late to begin addressing public policy problems related to earthquake predictions at the time one is made.

It has been said many times that earthquake prediction may actually be the beginning of problems and not the answer to reducing socioeconomic losses caused by damaging earthquakes. If public does not keep up with the scientific endeavour to predict earthquakes, that assessment will most likely be actualized. On the other hand, in both Japan and the US, standard measures to reduce urban earthquake hazards are long-term efforts. It may be decades before either nation can realize the full benefits of a seismically safe environment. Until then, damaging earthquakes will continue to pose a major risk to urban centres throughout the world and public policy alternatives must be sought. It is within that context that earthquake prediction has come to be regarded --at least in Japan, China, and California in the US --as a public safety alternative worth pursuing. That is not to say that earthquake prediction should be viewed as the primary solution in preventing socioeconomic losses and disruption, but rather as an important part of a comprehensive strategy for coping with the consequences of damaging earthquakes. Such a comprehensive strategy should, of course, consider all of the possible ways in which losses can be substantially reduced. If earthquake prediction is to be seriously considered as part of that strategy, then its potential must be analysed from both a scientific as well as a political perspective. From a public policy perspective, many complex problems remain and must be addressed if earthquake prediction is ever to be a viable means for reducing earthquake losses. The task of addressing these problems was assigned to one of the six working groups that comprised the second US-Japan workshop. The following summary reflects the group’s discussion and conclusions.

DISCUSSION TOPICS

Through a series of formal presentations and general discussion, the group addressed policy problems relating to earthquake prediction. The policy problems identified by the group fell into three categories:

- The general lack of scientific understanding needed to accurately predict earthquakes and the related uncertainties faced by those having to respond to such predictive state statements;
- The social impacts of earthquake warnings; and
- The complexities involved in planning the appropriate societal response to earthquake prediction and warnings.

Scientific Uncertainties

Except for the Tokai, Japan and the Parkfield, California earthquake predictions, specific criteria for issuing short-term predictions and/or public warnings are not well established. In the case of both Tokai and Parkfield, a long-term earthquake prediction was first issued. Similar predictions have also been made for other seismically active areas of the world. These predictions are based on impressive advances in scientific understanding of regional tectonic settings and the long-term seismic potential of specific geographic areas. Where Tokai and Parkfield differ from other areas of earthquake potential is in the intensive efforts that are being made to identify precursory phenomena that may occur before the event. In both cases, specific scientific criteria have been established for the issuance of short-term public warnings. Having well-defined criteria has facilitated interaction between scientists working on the predictions and those having to manage the response once a public warning is issued. This interaction has produced specific policies and procedures defining when and how the warning will be issued and response actions to be taken by governments and the general public. Perhaps the most important point to note is that in both Tokai and Parkfield, the public warning will be issued only when there is a very high level of certainty that the predicted earthquake is imminent.

For the most part. Tokai and Parkfield are experimental and do not represent current scientific capability to predict earthquakes. This is in part due to the lack of resources to do intensive study and monitoring. More importantly, the potential transfer of the techniques being used in Tokai and Parkfield to other seismically active areas is rather limited. While there is a real-time monitoring capability in most vulnerable urban areas in Japan and California, where applied it is neither intensive nor are the parameters for interpreting the incoming data, for prediction purposes, well defined. Under such circumstances the role of such groups as Japan's Coordinating Committee for Earthquake Prediction and the California Earthquake Prediction Evaluation Council is essential in providing commentary and advice on the possible implications of these data for future seismic activity. In California, this advice and commentary will almost always be accompanied by an assessment of the likelihood or probability that such future activity will occur. This advice is extremely useful to those having to make policy decisions relating to the level of response and to communicate warning information to the public. Unlike California, Japan does not consider issuing predictions or public warning statements unless a high level of certainty has been reached, as is the case in the Tokai district.

Social Impacts

In general, little is known about the social impacts of earthquake predictions. There have been very few cases to study and it is difficult to draw solid conclusions from such a small data base. If either the Tokai or Parkfield earthquake predictions result in an actual short-term public warning, it will provide the first opportunity to systematically study in some detail the social impacts of such an announcement. Until then, a few tentative conclusions may be drawn from the research literature currently available. We may assume, for example, that a public's response to an earthquake prediction will occur in specific societal contexts and will be highly dependent on how the prediction information is communicated.

Overall, it may be hypothesized that negative social impacts from an earthquake prediction can be reduced through greater public knowledge of and involvement in earthquake prediction programmes. Sheltering the public from trial predictions or experimentation may in fact result in greater negative social impacts by weakening the credibility of these programmes. It is likely that a public which is well aware of earthquake prediction programmes and is exposed to the complexities of its science will be more apt to accept warnings and be more tolerant of "false alarms," i.e., the nonoccurrence of an earthquake for which a prediction and/or public warning announcement has been issued.

How and when public warnings based on earthquake predictions are communicated seems to be a critical factor in determining social impacts. The terminology used to express prediction information in warning announcements is important. Expressing complex concepts such as earthquake potential or probability in simple terms that the public can understand is thought to be a way by which to improve earthquake prediction communication. The means by which prediction information is communicated is also important and there is little doubt that the mass media play a prominent role in relaying and translating this information. But in order for that role to be fully effective, the mass media must be able to differentiate between providing public information and covering and communicating news. It is widely felt that the role the mass media chooses to play during the issuance of a public warning will be a major factor in determining the social impact of such an announcement.

There are several factors that are also thought to influence how the public responds to warnings. The source of the public warning seems to make a significant difference. If the warning announcement is made by a high-level government official, such as the prime minister or a provincial governor, the public will give the announcement more credence and be more willing to take preventative measures. The time window assigned to a public warning seems to also make a difference. A warning that is sustained for longer than several days will most likely lead to high levels of anxiety among the affected population.

Whether or not a public warning announcement will have substantial socioeconomic impact is unclear. Much more study is needed on potential economic impacts and social behaviour. But without some real case studies to analyse, assumptions have to be made on a less than desirable information base.

Prediction Response Planning

Planning the societal response to an earthquake prediction dependent on two very important variables: (a) The level of confidence to the prediction; and (b) the risk implied by the predicted earthquake. Consideration of these two variables will provide a basis on which to plan an appropriate response to the predicted earthquake. While both California and Japan do consider these two variables as important, they differ substantially in the approach taken in planning prediction response actions. This is quite evident in comparing existing plans and programmes.

Japan is prepared to respond to the short-term prediction of the Tokai . earthquake. This is the only short-term earthquake prediction that Japan plans to make in the foreseeable future. Based on the scientific criteria established, a very high confidence level must first be achieved before a public warning announcement is made. While the potential for "false alarms" is recognized, it is not thought to be a major problem since the affected population will tend to regard the nonoccurrence of the predicted earthquake with "a mild tolerance." The concern with the Tokai earthquake is based on the enormous risk involved if it should occur without any warning. A substantial investment has been made in preparing the area to respond to the public warning announcement that would indicate that the great Tokai earthquake is imminent. Costly measures are planned, including the mass evacuation of high-risk areas. However, these actions are planned for responding to the predicted Tokai earthquake only and no other. It is felt that a prediction with the same high level of certainty cannot currently be made for any other part of Japan, and predictions with lower levels of confidence are not considered as beneficial.

California's prediction response planning efforts differ substantially from those of Japan. Within the parameters established by the state's short-term earthquake prediction response plan, a public warning announcement (or "advisory" as it is termed in the plan) could result from earthquake predictions that are assigned a low confidence level if the risk is deemed to be high. This approach is partly on the probabilistic approach used by US scientists to quantify the uncertainty involved in predicting earthquakes. It is deemed beneficial for the public to be aware of the uncertainties faced by scientists who monitor seismic activity in urban areas and attempt to comment on the possible implications for future activity. There is a perception that the public, media, and local governments in California want to know the earthquake potential of an area at all times, particularly following "anomalous" seismic activity. Given that most often it is the state that is the recipient of this information, its officials must be prepared to decide whether the situation merits a response or not. To assist officials with that process, the California Short-Term Earthquake Prediction Response Plan was developed. The plan attempts to meet three basic objectives:

(1) To describe the overall concept of operations for the state to identify state agency actions to be taken in response to an earthquake prediction;

(2) To scale the level of state response to the relative certainty or uncertainty of future predictions as well as probable consequences from particular earthquakes; and

(3) To outline actions that could realistically be carried out within a few hours to a few days.

Earthquake prediction response planning at the local level is critical to this approach, yet only the City of Los Angeles has such a plan. It has taken the city ten years to refine and test this plan. Most local jurisdictions in California do not have specific plans to deal with an earthquake prediction. The state does intend to provide local governments with response guidelines at the time that an earthquake advisory is issued.

STATE OF THE ART

For nearly twenty years, earth scientists have persistently sought to develop the expertise and methods to predict earthquakes. The pursuit of earthquake prediction has resulted in significant advances in scientific understanding of tectonic settings and long-term seismic potential. In a few instances --the 1975 Haicheng prediction being by far the most dramatic example --successful and accurate short-term predictions have been made. The overall consensus, however, appears to be that predicting earthquakes is a much more complicated process than was envisioned twenty years ago. For the foreseeable future, most earthquakes will probably remain unpredictable.

Some recent advances in the monitoring of seismological data have led to the ability to watch the evolution of geological events in real time. In the case of the Tokai and Parkfield areas, intensive efforts have been made to anticipate the kinds of precursory phenomena that may occur, and specific criteria have been established for the prediction of a specific earthquake. However, neither California nor Japan have the resources required for intensive study in all vulnerable urban areas.

On the policy side, some real progress has been made in the development of plans, programmes and procedures for responding to predictions of high certainty, such as the Tokai and Parkfield events. To a much lesser extent, some advances have also been made in preparation for responding to less certain situations, particularly in California, where advisories for low-probability events are being issued on a somewhat routine basis, with very few negative effects thus far.

For the most part, it is the need to expand scientific research that defines the state of the art of earthquake prediction. Both in Japan and the US, a greater investment is needed, particularly in areas that require intensive instrumentation, if the state of the art is to improve. Nevertheless, current research programmes aimed at gaining a better understanding of an area's seismicity remain critical in guiding how advanced, though scarce and costly technology is best deployed.

PROBLEMS TO BE SOLVED

Given the state of the art of earthquake prediction, many problems remain to be solved. Some of the problems identified are the following:

(1) Increasing the level of political and financial support for scientific research and instrumentation required in advancing earthquake prediction capability. This must occur on a worldwide basis if such intense efforts as Tokai and Parkfield are to be made transferable to

other areas with similar tectonic settings. If studies of other regions of the world were also intensified, progress would be much more rapid in producing a reliable set of precursors for different tectonic settings.

(2) Reducing the costs of seismic instrumentation.

(3) Improving the general public's understanding of earthquake prediction. Particularly important is to promote public understanding that a prediction indicates an increase in earthquake probability not that the earthquake is absolutely certain to happen.

(4) Improving the media's understanding of it's role in a public warning announcement resulting from a valid earthquake prediction.

The US and Japan are world leaders in the development and application of earthquake prediction technology. As such, continued cooperative research between these two nations may yield solutions to the many problems that still remain to be solved. In that spirit, the following recommendations for future cooperative research are made:

(1) World-wide research efforts should be intensified to produce a set of reliable precursors for different tectonic settings.

(2) Research and development efforts should be pursued in the application of advanced electronic technology to the production of less costly seismic array instrumentation.

(3) Better mechanisms should be established for the exchange of research findings related to the social impacts of earthquake predictions. It will be particularly important that such mechanisms be in place at the time that either the Tokai or Parkfield earthquake prediction result in an official public warning announcement.

(4) Further US-Japan workshops on the reduction of urban earthquake hazards should be held on a more frequent basis as these provide the current best means for exchanging information and experience. Modifications or changes in the direction of either of these two countries' earthquake prediction programme may have important implications for the other countries and these workshops are a good current forum for keeping up with such trends.

CONCLUSION

Many policy problems still remain in the development and application of an operational earthquake prediction capability. These problems must be solved if earthquake prediction is ever to be a reliable and effective method for reducing the socioeconomic losses associated with earthquakes. If earthquake prediction is to be seriously considered as an important element of a comprehensive earthquake hazards reduction strategy, current scientific and response planning efforts must be maintained or accelerated. Regardless of how fast or slow we proceed with efforts to advance earthquake prediction, it should be clear that science and policy must move in parallel fashion.

2-2 WORKING GROUP 2: PUBLIC AND PRIVATE AWARENESS

INTRODUCTION

The working group brought together a number of persons, primarily from Japan and California, to discuss their earthquake hazard reduction experiences. Fifteen papers were presented and discussed. Topics included citizen's information needs, tsunami planning, insurance, government programmes, and engineering solutions. The broad range of topics, the number of papers presented, and the large audience prevented in depth discussion or the reaching of a working group consensus. However, discussions did allow the following observations.

WORKING GOUUP PRESENTATIONS

Eisner stated that since earthquakes can affect large regions, preparedness planning must initiate efforts among a number of governmental jurisdictions at all governmental levels, between jurisdictions, and in the private sector. He stated that the Bay Area Regional Earthquake Preparedness Project (BAREPP) and Southern California Earthquake Preparedness Project (SCEPP) provide staffs of planners, geologists, and architects to serve as consultants and promote preparedness activities. Policy Advisory Boards provide guidance and links to key organizations and serve as advocacy groups. Resource centres provide reports, videos, slides, and other assistance information upon request. These projects have been successful in gaining government support for preparedness activities.

Preuss used case studies to describe a framework for reducing tsunami damage: Understand the exposure, assess vulnerability, and reduce risks. Risk reduction programmes include warning, education, land-use regulations, building standards, maintenance programmes, construction of defensive structures, and fire and hazardous material spill mitigation.

Mihailov stated that preventive measures should be taken into consideration in the physical and urban planning of an area. His observations were based on earthquakes in Skopje in 1963 and Montenegro in 1979. Earthquake hazard reduction standards must be considered along with other criteria of a technical, economic, functional, esthetic, and compositional nature. He said research is needed on the level of protection and safety criteria that are economically acceptable.

Hori reported on studies in Kanagawa Prefecture where shaking intensity and ground failure data are used in land-use decisions. The data, stored in 6,500 meshes, have been used to estimate damage to the region, to estimate necessary response measures, and to establish design standards. He called for new design standards for high pressure gas and other dangerous materials.

Roth stated that 15 to 20 per cent of California homes and businesses has insurance coverage for earthquake damage. He expressed concern that insurance companies be able to pay claims, that policies should be priced according to the risk, that insurance should be more available, and that procedures and incentives to mitigate risks be developed. He pointed to data needed to answer these concerns. He also described some interesting differences in the earthquake insurance programmes in Japan versus those in the US. In Japan, earthquake insurance for dwellings and household contents was first offered on 1 June l966, prompted by the 16 June 1964 Niigata earthquake. Although sold in conjunction with a homeowners policy, it is actually a separate policy with its own terms and conditions. It is sold with the support of the government's reinsurance scheme without relying upon overseas markets for reinsurance.

In the US, a homeowner policy covers earthquake damage only if caused by an ensuing fire. In Japan, a homeowner's policy will not pay for any earthquake caused damage (there is an "extra expense cover" which is a general policy condition paying up to 3 per cent of the insured amount). As can be seen, a Japanese earthquake policy also covers fire damage which a US policy does not need to do. In the US, an earthquake policy pays for all damage less a deductible. A Japanese policy only pays up to 30 to 50 per cent of the loss.

Currently, no more than, ¥1500 billion (a little over US$10 billion) can be paid out in insurance claims. This limit is set by the Japanese Diet. In the event that the total amount of claims exceeds this amount, payments will be reduced in proportion to what excess amount is to the total amount of claims. The extent to which the government participates as a reinsurer depends on the size of the earthquake. As is usual in a reinsurance agreement, amounts to be paid are determined by lawyers:

(1) First ¥55 billion of claims: Borne 100 per cent by private insurers.

(2) Amount exceeding 55 billion, but less than ¥280 billion: Borne 50 per cent by private insurers and 50 per cent by the government.

(3) Amount exceeding ¥280 billion, but less than ¥1,500 billion: Borne 95 per cent by the government and 5 per cent by private insurers.

Therefore, the exposure of private insurers is limited to ¥228.5 billion (of which ¥118.5 billion is actually borne by the Japanese Earthquake Reinsurance Co, Ltd, which was established in 1966). This is almost US$2 billion.

Kimura described insurance programmes in Japan in more detail. Some risks are insured by the government, while extra expense coverage up to ¥100 million per accident and coverage for industrial risks is available in the private sector. He pointed to actuarial difficulties in the programme caused by the relatively short historical record and the tendency for adverse selection among customers. Japanese insurance policies do not encourage risk reduction.

Smolka said that it was necessary to encourage loss control, perhaps by charging higher premiums for high risk coverage. However, he said high premiums would discriminate against much of low cost housing worldwide. For example, adobe is use extensively for housing in many countries. He said in as much as insurance is used to fund the start of recovery, it is necessary to have a realistic idea of possible losses so that the exposure will be less than the capacity. He said models of probable maximum loss are needed, but, although they are simple in theory, there are practical problems. For example, when fire follows earthquake, there is little on possible losses. He stated that primary insurers have more data information to make risk decisions than do the reinsurance companies.

Hayashi reported on studies of how people reacted to the 1983 Aomori and Akita earthquake. Response on questionnaire returns exhibited psychosomatic disorders. For example, it took 80 per cent of the respondents three days to return to regular daily routines. He reported that inquiry calls and expressions of sympathy remained heavy for a week, and that substantial help was provided voluntarily by families and the community. He concluded that weaker social relationships existing in urban areas may cause more difficulties in supplying the informal help exhibited in the more rural areas.

Omachi reported on his studies based on questionnaires completed in California and in Japan. In both locations respondents wanted more information on personal/voluntary preparedness. He noted an over-dependence in Japan on government action, and concluded that Japanese programmes should stress self and mutual help action.

Miyagawa reported on private-sector preparations for the predicted Tokai earthquake. The comprehensive programme included vulnerability analysis, employee training, and hazard mitigation of buildings and manufacturing processes.

Saito described the Minato Mirai 21 project, its earthquake design criteria, and other disaster preparedness features. He believes that a comprehensive preparedness effort incorporating land-use planning, design standards, and the establishment of a defence organization could mitigate earthquake risks to an acceptable level.

Shioji described disaster preparedness activities in the Keihin Designated Area, Kanagawa Prefecture. The Conference, an organization of 162 private companies, including five refineries and two petrochemical complexes, issues tank design standards, trains members' employees, and holds annual exercises.

Hamada reported on models to evaluate the ability of oil well casings to accommodate earthquake forces.

Langenbach discussed historical preservation and seismic risk. He said most historic buildings can not be made to conform to present codes, and that the lay public understanding of the word "failure" and its engineering meaning differ. He discussed various attempts to strengthen historic buildings and the effect on the buildings' historical qualities and appearances.

Tobin described earthquake problems in California. He said that the California earthquake hazard reduction programme must be improved, but it is difficult to get the attention of the leaders who make a difference. He compared the levels of government financing in Japan and in the US. He called for a new strategy to mobilize support for improved programmes. The strategy is based on clarifying liability, stressing business management's fiduciary responsibilities, providing incentives, describing the nature and range of estimated economic impacts, and enlisting statewide groups representing local governments and businesses.

OBSERVATIONS

Earthquake preparedness is part of an on-going process that moves from awareness of the hazard to hazard reduction activities. Preparedness efforts seldom reduce hazards; they promote hazard reduction action. There are many similarities between programmes in Japan and in California. Although the earthquake risk is nationwide and statewide, programmes are geographically focused. In Japan, attention is focused on Shizuoka, Kanagawa, and Kanto prefectures largely because of the prediction of the "Tokai earthquake" and the great 1923 Kanto earthquake and fire. In California, preparedness efforts focus on the Southern California and in the San Francisco Bay areas where probability of large earthquakes exceeds 50 per cent within twenty to thirty years. Earthquake programmes, research, and state/nationwide efforts apply elsewhere, but the emphasis is in these regions.

The major threat in both countries is posed by inadequate existing development, much of which is built in similar fashion, and by the threat of multiple fires and the release of hazardous materials after earthquakes. Both countries need effective programmes to reduce the hazards posed by existing structures and an emergency response capability, ready and trained, to respond to hundreds of incidents spread over a wide area affecting millions of persons and numerous jurisdictions.

The programmes differ in the amount of financial resources committed by state/prefecture and federal governments. It was estimated that the National Land Agency of Japan alone spends an average of $166 per person per year, while the US National Earthquake Hazard Reduction Programme spends approximately $0.25 per person per year. The State of California spends approximately $1.00 per person per year. The City of Yokohama spends $4 per person per year, and the Tokyo five-year earthquake hazard reduction plan will cost $21 billion ($400 per person/year). California's metropolitan public entities (LOS Angeles, Orange County, San Francisco), and recent approval of a $80 million statewide bond measure for earthquake improvements in low cost housing have demonstrated an increase in the commitment of resources to hazard reduction efforts, but at only several dollars per person per year.

The similarities between the hazards as well as the differences and similarities in existing programmes made the workshop information exchange of value to all parties.

WHAT DO WE NEED TO KNOW?

Although funded to different degrees, both countries lack sufficient resources to reduce earthquake hazards as quickly as desired, and additional resources are limited. Thus, an acceptable level of risk needs to be defined as do criteria that will help justify proper funding levels, determine future preparedness needs, and set priorities among competing activities.

Additional vulnerability studies are needed in geographical areas where existing concern and awareness is high and in areas where the awareness of the earthquake hazard does not support even rudimentary programmes. These studies are needed to plan government and private-sector programmes, to prepare emergency response plans, to determine insurance exposure, and to mobilize political support. Vulnerability studies should not be undertaken unless those who will ultimately be expected to use the results are consulted and are involved in the effort.

Financial impact studies of direct physical and secondary losses due to secondary effects such as business interruption are needed. More data are needed to determine the full exposure of the insurance industry as a result of several lines of coverage. Estimates on the economic effects on units of government and private companies are needed to determine the effect on their own operations. All entities need workable strategies to prepare for economic aftershocks. Information is also needed to encourage the insurance industry to improve policies, encourage mitigation, and avoid the practice of purchasing insurance as an alternative to reducing hazards.

Structural retrofitting efforts need to be accelerated in both countries. More research is needed to develop financially attractive techniques. Techniques are also needed that will allow retrofitting historical structures without diminishing the historical authenticity, cultural values, and the importance of these unique buildings.

Preparedness efforts carried out by the government and in the private sector depend on practical and easy to apply knowledge. Added effort must be exerted to make existing information available and usable by those who are responsible for preparedness efforts. Preparedness projects carried out in California serve as good models for Japan.

COLLABORATIVE CONTINUING INFORMATION EXCHANGE

The participants recognized the importance of continued communications efforts between representatives of the two countries. It was recommended that plans be initiated for the 3rd US-Japan Workshop on Urban Earthquake Hazards Reduction, and that it be held in two years. It is believed that four years is too long an interval between meetings. It was also recommended that active participation in the International Decade for Natural Disaster Reduction be utilized as a mechanism to foster the needed international information exchange. It was noted that the Governor of California has proclaimed the 1990s as the "California Decade for Natural Disaster Reduction."

2-3 WORKING GROUP 3: ESTIMATION OF EARTHQUAKE VULNERABILITY/DAMAGE

I NTRODUCTION

Numerous studies have shown that the greatest current threat to life and safety arising from a moderate to severe earthquake occurring near urban areas is posed by existing hazardous structures. Many hazardous . structures and facilities do exist in Japan and the US because many buildings were constructed while earthquake engineering was in its infancy; the earthquake resistance requirements of building codes were less stringent than at present, though even new codes are not infallible.

Although seismic risk can be reduced by improving the earthquake-resistant design, construction, and maintenance of new structures, the number of older hazardous buildings in our cities is enormous. One of the most effective ways to decrease their risk is first to conduct reliable vulnerability assessments of existing structures (which requires estimation of possible damages) and then to develop and implement effective ways to upgrade (retrofit) structures identified as hazardous. The need to improve damage estimation of structures was clearly identified during the First US-Japan Workshop (USJW) on Urban Earthquake Hazard Reduction, held at Stanford in 1984, where it was recommended that greater efforts and Thus, resources be directed to improve the quality of damage estimates.
in organizing the second USJW it was decided that one of the main areas of focus should be "Vulnerability Assessment/Estimation of Earthquake Damage." Another closely related issue that was identified is the need to upgrade (rehabilitate or retrofit) existing structures.

In view of these needs, the Organizing Committee of the second USJW assigned the task of addressing the problem improving seismic vulnerability assessment and upgrading of existing structures to Working Group 3. Two keynote addresses and twenty-five abstracts addressed these problems, and they constituted the basis for the group's discussions, conclusions, and recommendations, which are summarized below.

SUMMARY

FORMAT (ORGANIZATION) OF WORKSHOP

Following the format of the technical session programme, each Working Group was assigned one and a half days (the afternoon of 27 July and all of 28 July) for presentation and discussion of the papers that had been prepared for this workshop. Because the first working session was a joint session with Working Group 4 (Fire and Hazardous Materials), Working Group 3 actually had only one and a quarter days (nine hours) for presentations questions, and discussions of the twenty-five papers and for a final general discussion to synthesize the group's conclusions. The main objectives of this second workshop, around which the groups organized their discussions were the following:

-To discuss the state of the art (as well as the state of the practice) 1/

- To identify research needs: problems that need to be solved (as well as development and educational needs) 2/
- To forward recommendations regarding the best way to solve identified problems and formulate recommendations for future Japan-US cooperative research programmes.

Because there were so many papers and two keynote addresses, it was necessary to limit the time each author was allowed for presentation to only seven minutes. Although the enforcement of this limitation was not easy, all the participants were able to present their thoughts and there was time for a brief discussion of each presentation. This was possible because of the cooperation of the participants and the excellent bilingual intervention of the co-chairmen of the working sessions, Professors Kameda and Hoshiya.

Although in general the organization of the Working Group sessions was excellent, many participants felt that there was room for improvement. Concerns were expressed regarding the benefit of having a joint session at the beginning of the workshop. Many participants felt that the joint session should be scheduled at the end of the working sessions, Furthermore, many participants favoured having a joint session with Working Group 6 (Long-term Recoverv/Reconstruction) rather than with Working Group 4. Another concern was that the time allocated for discussion of the topics was not enough. Thus in future workshops, it seems that the number of presentations should be limited or the time allocated for working Group sessions should be extended. A compromise solution would be to require that each participant prepare his/her paper before the workshop, so that a panel of experts on the different topics to be covered can review and synthesize them according to the objectives of the workshop. This panel of experts would then report their findings during the technical session of the workshop, and these findings would be the subject of discussion rather than the papers themselves.

The first technical session on the afternoon of Wednesday, 27 July, a joint session with Working Group 4, was attended by fifty participants. During the second session on Thursday, 28 July, thirty participants were present.

TOPICS OF DISCUSSION

The abstracts of the twenty-seven papers presented and discussed in this session addressed many different problems, these problems can be grouped under the topic areas given in table 1. Table 1 also shows the number of presentations for each country on each topic. The total number of thirty-two exceeded the total number of papers presented because some of the papers, particularly one of the keynote addresses, covered more than one topic area.

A brief summary of the discussions, what has been learned, and what are the research, development, and educational actions needed to reduce earthquake vulnerability in our cities are presented below. The following summary has been facilitated by instructing each of the presenters to address the following four questions:

(1) How is the paper related to earthquake hazard mitigation and particularly to the estimation of earthquake vulnerability and its reduction?

(2) How do the results presented affect the state of the practice and the state of the art in this area?

(3) What are the research, development, and educational actions needed to reduce earthquake vulnerability in our urban areas, and in general to improve mitigation of seismic hazards?

(4) What kind of cooperative research programme would you like to see developed to improve the state of the art in earthquake hazard reduction? Name specific subjects to be studied.

Table 1.

SEISMIC HAZARD ASSESSMENT

Seismic hazard can be considered as the function describing the probability of occurrence of seismic ground motions of various intensities (or damage potential) at a given site (urban area or region), during a given period of time. Thus, seismic hazard assessments are attempts to forecast the likely future seismic activity rates and strengths, based on knowledge of the past and present. Significant uncertainties arise, partly because relevant data are generally scarce and poor in quality. Earthquake hazard assessment is of great importance in coping with the practical aspects of the earthquake problems. Preparing for future earthquakes requires knowledge of the seismic activity that can be expected. Since earthquakes, earthquake ground motions, and earthquake ground shaking at the foundations of structures cannot be precisely predicted, all relevant information about earthquake hazard in the vicinity of urban areas must be used.

State of the Practice and State of the Art: From the papers presented and the ensuing discussions, it was concluded that for reliable seismic hazard assessment it is important to know as much as possible about future earthquakes --likely location, magnitudes, frequency of occurrence, and intensity or even more precisely the damage potential of ground shaking at the site under consideration. Ideally, the size, location and time of occurrence of damaging earthquakes should be predicted, so that planners would know precisely when and where earthquakes would occur during the lifetime of a project, and what the nature of the ground shaking would be at the site. At present, such precise predictions are not possible, so assessments of future seismicity can only be approximate. The seismic hazard models used in estimating risk must account for the influence of 10eal conditions, such as soft soil or irregular topography, i.e., they must include the results of microzoning studies.

At present, most of the estimations of the seismic hazard at a given region are based on the information provided by seismic maps, which divide the country into zones with different categories of expected intensity of shaking. The reliability of these maps depends on how the intensity of shaking is quantified. Usually, seismic codes specify such intensity as the expected coordinates of smoothed Linear Elastic Response Spectra (LERS). Therefore, the reliability of present methods clearly depends on having an adequate data base of recorded ground motions. Although the data base of ground motions recorded has expanded greatly in the past two decades and now contains several thousand records, it is not adequate for seismic hazard assessment throughout the entire US, particularly in the midwestern and eastern seismic regions.

A more reliable intensity parameter than the LERS for representing the damage potential of possible seismic shaking is needed. The estimation of the earthquake input energy, EI,appears to be the solution.

Research Development and Educational Needs: Research results and the lessons learned from recent earthquakes indicate the need for more thorough microzonation of our urban areas, and the need to estimate the EI of the recorded ground motions, taking into consideration the various possible dynamic characteristics of different types of structures.

CONCEPTS OF DAMAGE VULNERABILITY AND VULNERABILITY ASSESSMENT

Concept of Damage: In his keynote address, Dr. Kaji, after pointing out that there is conceptual confusion of damage estimation with vulnerability assessment in the case of earthquakes, and therefore that there is a need for clearly defining the concepts and contents of the terms that are used in damage estimation and vulnerability assessment raised the following basic question: What is the meaning of "damage"? While damage traditionally implies death, injuries, or destruction of buildings and facilities by disaster, there are two other types of damage that are consequences of this "direct damage," i.e., "functional damage" and "indirect damage. " Clear definitions of these consequential damages are given by Dr. Kaji in his keynote address.

The next question that was addressed was the following: What is acceptable damage? Economic considerations indicate that the design and construction of any kind of facility (building structures, lifelines, etc.) have to be made accepting a certain degree of damage (acceptable damage). - The concept of acceptable damage involves monetary loss, but loss of life is in general not acceptable. A broad consideration would indicate that for a city, acceptable damage should occur infrequently and should not have an unduly severe impact on the population. National considerations would indicate that acceptable damage should not have a severe impact on important government services, military installations, etc. It is important to determine what is acceptable damage and how to design new structures and upgrade existing structures to limit damage to the acceptable level.

<u>US and Japan Present Acceptable Damage Criteria</u>: The criteria for acceptable damage in these two countries are similar and briefly embody the following standards:

- For moderate levels of earthquake ground motions, damage should be repairable at reasonable cost.
- For major (extreme) levels of earthquake ground motions seismic code requirements are intended primarily to safeguard against major failure (collapse) and loss of life, but not to limit damage, to maintain functions, or to provide for easy repair.

It was agreed that it would be desirable if compliance with seismic code provisions resulted in structures that even in the case of extreme earthquake ground motions, allowed structural damage to be limited to a repairable level; however, it was recognized that damage control design is a very complex problem at present.

<u>Research Development and Educational Needs</u>

- To establish a "Glossary of Standard Terms" regarding the use of the concept of damage, with clear definitions of the different types of damage (physical, direct, functional, indirect, etc.).
- To develop reliable methods for estimating the different types of damage, particularly post-earthquake, functional, and indirect damage; this should cover not only buildings, but any type of structure or facility (lifelines, dams, etc.), as well as long-term effects on people and the economy of the region.
- To determine more precisely what constitutes "acceptable damage."
- To develop code recommendations that include "damage control," at least for certain types of facilities (schools, hospitals, etc.), and to design construction methods that provide for such damage control.

<u>Concepts of Seismic Vulnerability and Vulnerability Assessment</u>: Seismic Vulnerability is defined as the function of describing the probability distribution of damage to a given element or system under the action of earthquakes in general, i.e., earthquakes of various different dynamic characteristics (intensity predominant period etc.). In the

discussion of this subject, the need to distinguish between "Vulnerability Assessment" and "Damage Estimation," which is the assessment of the loss of buildings and lives to a specific earthquake was pointed out. " Urban or Regional Vulnerability Assessment" examines not the damage itself, but the degree of probability for damage to occur. 3/ However, these two concepts are related, and their studies should go hand in hand.

State of the Practice and State of the Art in Vulnerability Assessment: Although several different philosophies, approaches, and methods were presented and discussed by the participants, the methods can be classified in the following two main groups: (1) General methods forming part of seismic risk evaluation of the whole urban area; and (2) particular methods for evaluating earthquake-resistance of individual existing buildings. Most of the proposed general methods consist of the following three main steps: (1) The collection of available data for the region -that is, the geological hazards (ground shaking, liquefaction potential, ground rupture potential, landslides, etc.), land use and occupancy construction type, and high priority structures; (2) a first-cut screening (bird's-eye view) to identify high risk sub-areas from which a preliminary list of high risk structures can be sorted; and (3) a more refined screening, using an inspection questionnaire to select a reduced population of hazardous structures.

Although some of the methodologies that have been developed have already been applied by federal agencies and consulting firms, the problem that still remains is the calibration of such methodologies. Regarding the particular methods, a variety of evaluation methods for individual existing buildings has been developed and applied to benchmark structures. In Japan, "Guidelines for Evaluation of Seismic Capacity of Existing Reinforced Concrete Buildings" was published in 1977, and since then has been applied in many studies. In the US the development of such methods was slower -- in 1987, when the Applied Technology Council (ATC) published the ATC-14 Report, "Evaluating the Seismic Resistance of Existing Buildings" which is the most comprehensive of all the methodologies that have been developed up to now in the US.

In the presentation of the papers on the current practice in vulnerability assessment and the discussion that followed them, the following main needs were identified as necessary to improve the state of the practice:

- The need for instrumenting more buildings to monitor their seismic response (performance).
- The need for more refined structural grading and the development of more efficient screening methods.
- The need to increase the number of pre- and post-earthquake structural evaluations .
- The need to study in more detail the damages or even disasters caused by performance of non-structural components.
- The need to make more reliable assessment of soil liquefaction and foundation failures.
- The need to improve the microzonation of our urban areas.
- The need for collecting available data and data base development.

Most of the methods that have been developed and used in practice are based on estimating the Capacity/Demand ratios, using criteria specified in the codes enforced at the time that the methods were developed. A review of the state of the art has shown that in general, this approach is not satisfactory, because even in present codes the reliability of the procedures for evaluating seismic demands and capacities is highly questionable. The main problem in identifying hazardous buildings is in the estimation of their real response to severe earthquakes that might occur in the future. This is a complex problem, because the prediction or estimation of the response of a structure depends on an adequate knowledge of at least the following items: (1) Earthquake hazard at the site; (2) local soil conditions; (3) type, size, shape, and detailing of the foundations and superstructures as well as non-structural components of the superstructures, and the type and quality of connections between these components; (4) mechanical characteristics of the materials and of the structural elements, and their connections under earthquake-type excitations; (5) response of the structure to the ground-shaking introduced at the foundation according to the estimated earthquake hazard at the site (i.e., item l); and (6) desired level of safety or acceptable level of damage. Thus, to gain sufficient information to be able to judge the degree of vulnerability of a given structure usually requires extensive structural and stress analyses and many judgmental decisions.

Research Development and Educational Needs: (1) The reliability of vulnerability assessment must be improved. There is a need to evaluate the relative reliability and effectiveness of the different screening techniques presently used or proposed for rapid identification of buildings that require detailed evaluation; and then to calibrate existing procedures for determining damage levels of existing buildings. (2) Integrated analytical and experimental research addressing the damage threshold and ultimate capacity of the structural components, and of the overall soil-foundation-superstructure and non-structural components of existing buildings, is urgently needed. High priority should be given to research, analysing the behaviour of real structures up to failure. (3) Appropriate instrumentation should be installed in the soils surrounding existing buildings, at various locations of the foundation, the superstructure, and on the non-structural components, to record the ground motions in the free field area at different depths of soil; the motion of the foundation and the deformations and accelerations at different height levels of the buildings during an actual earthquake. This research should be complemented with experimental laboratory investigations on full-scale structural members and/or non-structural components and three-dimensional structural systems and buildings. (4) There is a need also to develop improved methods for identifying the physical properties and mechanical characteristics of the materials in existing structures. Modern non-destructive field testing methods and the necessary equipment should be developed.

A data base of case histories should be developed. Most especially, an "International Organization" must be developed that will collect all data regarding strong ground motion instrumentation in the world, process and distribute the data.

UPGRADING (RETROFIT) AND REHABILITATION OF EXISTING STRUCTURES; NEW DEVELOPMENTS FOR HAZARD REDUCTION

Upgrading or retrofitting of a structure (usually called "strengthening" in the technical literature), is the judicious modification of the strength, stiffness, damping, and/or mass (or in more general terms the modification of one or more of the dynamic characteristics) of the structural system to improve the structure's performance in future earthquakes, Upgrading is usually called strengthening, because generally it involves increasing the strength of the existing members or adding new members that increase the lateral force resistance of the whole structure. However, in some cases, the best upgrading strategy will be simply to reduce the mass without changing the strength, and/or increasing the damping (adding frictional or energy dissipation devices), and/or making the structure more flexible and/or weaker.

Seven papers were presented on this subject. From these presentations and the ensuing discussions, it was clear that much effort is going in to developing upgrading techniques for engineered buildings. Only one paper was devoted to the improvement of non-engineered buildings. This is an area where research and development are urgently needed.

State of the Practice: Relatively there have been very few cases of upgrading of existing buildings. School buildings have been upgraded in Shizuoka Prefecture (Japan) and in the State of California (US). The most commonly used technique is just to strengthen the building with R/C shear walls, and/or steel braces. It is only recently that other types of state as well as privately owned buildings have begun to be upgraded. Significant efforts have been devoted to the upgrading of existing highway bridges in California as well as in Japan. Most of the upgrading work up to now has consisted of adding steel restrainers at the hinges and expansion joints at the girders. Upgrading of the supporting columns, the substructures, and the accesses to the bridges has already been started.

State of the Art: To select the proper upgrading strategy and techniques, it is necessary to conduct the following step-by-step studies: (1) Evaluation of the seismic hazard at the site; (2) evaluation of the dynamic characteristics of the existing structure; (3) selection of the best strategy for upgrading the structural system; and (4) the development of alternative schemes for upgrading the whole soil-foundation-superstructure and non-structural components. Alternative schemes should be evaluated and the most appropriate solution should be selected. In the past, too much emphasis has been placed on upgrading existing buildings by using conventional or traditional techniques, i.e., stiffening and strengthening them. In recent years, significant research efforts have been devoted to control the energy input, EI to the foundation of the building and/or dissipating a large part of this EI by installing energy dissipation devices. As a result of these research efforts, several base isolation and energy dissipation devices have been developed and tested, and some have already been applied in upgrading existing structures. From the discussion held on this subject, it was concluded that:

- Base and floor isolation techniques, as well as the use of energy dissipation devices, are reliable for upgrading certain types of structures.

- Response control for tall structures is still in the stage of experimental research, but its reliability is improving very rapidly.
- Due to the continuous increase in population as well as in the high technology development taking place in our urban areas, the pressure for improving earthquake hazard reduction by controlling the response of new and, particularly, existing structures and other facilities has increased tremendously. It is believed that the passive as well as the active control of the response of these structures offers great potential for reducing the seismic vulnerability of our cities.

Research, Development, and Educational Needs; (1) Efforts should be made to develop effective strategies and techniques for upgrading hazardous buildings. (2) Special attention should be paid to investigating efficient ways of upgrading different types of foundations , and this should be followed by the necessary development. (3) Research into the use of techniques based on energy methods, and on the use of base isolation, energy dissipation devices, and/or pre-stressing schemes should be pursued vigorously. This should be followed by development of such devices, and the necessary technology so that these devices can be applied economically and reliably in practice. (4) The active control of the response of different types of structures using "feedback control" as well as "feed-forward control," and the advantages and disadvantages for practical application, should be thoroughly investigated. (5) The lag time for research results to be reflected in building codes , or to be put into a form that can be used in practice, should be reduced.

IMPLEMENTATION AND PUBLIC POLICY DECISION

Three papers prepared by Japanese researchers pointed out that to improve earthquake hazard reduction, it is necessary not only to conduct research in order to improve estimation of damage, seismic hazard, and vulnerability assessments, and to develop and implement better upgrading techniques, but also to develop and implement disaster prevention planning. The earthquake preparedness programme for the Shizuoka Prefecture was presented and discussed as one of the rare eases in which public policy has been implemented. The need for optimization of planning of urban land use was emphasized, pointing out the need to consider socioeconomic factors as well as the natural conditions of the sites where the urban activities are located. The socioeconomic factors include land price, transportation accessibility, utility supply, and disposal services. The natural conditions may include soil and landscape conditions, atmospheric quality, natural hazard risks, and so forth.

FUTURE COOPERATIVE RESEARCH PROGRAMMES

All the participants agreed on the need for developing cooperative research programmes between US, Japan, and other countries. It was unanimously agreed that in view of the rapid advance in knowledge and technology developments in all the topic areas discussed during the sessions of Working Group Three, it would be highly desirable that workshops like the present one be held more frequently.

As summarized previously, significant research, development, and educational needs in the different topic areas considered by this Working Group have been identified. Among the topic areas on which it was agreed that cooperative research would be of common interest, the following were identified.

Seismic Hazard Assessment: (1) To collect all the data available in Japan and US (as well as worldwide) regarding recorded ground motions. To process such data in a standard form (to be agreed upon) and analyse the damage potential of the recorded ground motions. The use of the Energy Input, EI at the foundation of the structure should be investigated; (2) to adopt, or to develop if necessary, an efficient automated data base system for searching the literature available in this area as well as any other of the topic areas covered by this working group; (3) To put forth joint efforts in designing and installing dense-array instrumentation in regions where severe earthquakes are expected in the near future; (4) To conduct studies of probability of ground failures.

Damage and Vulnerability Assessments: (5) To develop reliable methods for estimating the different types of damage (physical, direct, functional, indirect); (6) To determine what constitutes "acceptable damage"; (7) To develop code design recommendations for "damage control"; (8) To conduct foundation damage studies; (9) To develop efficient ways of instrumenting the whole soil-foundation, superstructure, and non-structural component system, and to monitor the seismic response of the whole system; to instrument different types of structural systems; to process data; to analyse them, and to disseminate the results; (10) To conduct integrated analytical and experimental studies to determine actual capacity of real structures (foundation, superstructure, and non-structural components); (11) To develop reliable methods for rapidly screening large inventories of structures (particularly buildings); (12) To conduct vulnerability assessment of urban areas located in regions of high seismic risk, and then to evaluate reliability of pre-earthquake assessment with post-earthquake evaluation of the vulnerability; (13) To conduct studies and develop reliable methods for assessing lifeline systems vulnerability.

Upgrading of Existing Structures: (14) To investigate effective ways of upgrading different types of foundations; (15) To develop effective strategies and techniques for upgrading engineered as well as non-engineered buildings; (16) To conduct studies on the feasibility of using passive and active control of the seismic response as practical techniques for upgrading existing structures.

CONCLUSIONS

The two technical sessions of this Working Group brought together researchers, public officials, and practitioners from Japan, US and several other countries that are concerned with the problems associated with the estimation of seismic damage, vulnerability assessment, and upgrading of existing structures. It was agreed by all the participants that the technical sessions were very valuable, and that there is an urgent need to improve both the present state of the practice and the state of the art in damage estimation, vulnerability assessment, and upgrading of existing hazardous structures. The presentations and the ensuing discussions identified many problems that still need to be solved as well as other problems in which existing solutions are not reliable and therefore need improvement. These presentations and discussions revealed also that there still exist great differences in the approaches taken to solve certain problems, not only by researchers from different countries, but even among the researchers of one country. A good example of this is in the approaches to developing reliable methodology for rapid screening of large inventories of buildings to identify those that may pose a life/safety hazard. This clearly points out the need for more frequent opportunities for interacting. Thus, it was agreed by all participants that this type of workshop should be held regularly at a shorter time interval than the present four years. The greatest threat to life and safety arising from a large earthquake is posed by existing hazardous structures. Present earthquake hazard reduction programmes are inadequate to make our cities safe against earthquakes. Thus, international research efforts should be devoted to developing better programmes. This will require improving methodologies for seismic hazard assessment, vulnerability assessment, and upgrading existing hazardous structures. Finally, such a research programme must be implemented, which demands that the support of public offices and the private sector be aroused and maintained.

NOTES

1/ Objectives added to Working Group Three.
2/ Ibid.
3/ See Kaji, Keynote Address attached.

2-4 WORKING GROUP 4: FIRE AND HAZARDOUS MATERIALS FOLLOWING EARTHQUAKES

INTRODUCTION

This section summarizes the discussions of Working Group 4, concerning the problems of fire and hazardous materials following earthquakes, in the context of urban earthquake hazard reduction.

The working group sessions consisted of informal presentations by individual participants, free-spirited question and answer exchanges, and general discussions on the problems involved in reducing the potential for catastrophic losses posed by these two major earthquake hazards. The working group meetings occurred on the afternoon of the first day of the workshop (meeting jointly with Working Group 3), and the entire second day. The morning of the third day was devoted to summaries of each Working Group's findings.

ESTIMATION OF EARTHQUAKE VULNERABILITY VIS-A-VIS FIRE AND HAZARDOUS MATERIALS FOLLOWING EARTHQOAKES

The discussions of the joint meeting of Working Group 3, which is focused on estimation of earthquake vulnerability and damage especially with regard to structures, and Working Group 4, can be organized according to three aspects:

Analysis

The development and acceptance of analytical models differs significantly, between the two Working Group areas. That is, while analytical frameworks to model failure mechanisms and vulnerability for structures are relatively advanced, similar analytical model development is much less advanced for fire, hazardous materials, and human injury (the latter was within the purview of Working Group 3).

The significantly different level of development was illustrated by the detailed presentations and modeling of D. Hoedajanto, concerning shear response of reinforced concrete panels, and M. Murakami, regarding the seismic capacity of existing low- and medium-rise reinforced concrete buildings and damage, which contrasted with the following presentations: T. Takeda, regarding estimation of initial fire outbreaks following earthquakes, based on an empirical approach; E. Baumgardner, who discussed the currently just-starting hazardous materials-related data collection efforts in California; and two papers on human injuries: T. Mochizuki, concerning an analysis of factors in ordinary living environments contributing to human casualties due to earthquake, and H.O. Murakami, who presented an innovative approach to diagnosing or assessing household seismic risk.

Response

The discussion revealed that there is a general consensus that normal emergency responses will be overwhelmed following an earthquake, both with regard to hazardous materials (Baumgardner) and fire (Borden), the latter of whom presented the status of earthquake planning by the Los Angeles City Fire Department. Based on his presentation and the ensuing discussion, it appears that there is only one city in the VS which is seriously training ordinary citizens for fire fighting and other emergency response actions, as opposed to the situation in Japan, where there appears to be numerous communities engaged in these activities. Borden further pointed out that the attitude of the citizens is excellent.

Mitigation

Due to time constraints, relatively little was discussed in the joint meeting regarding mitigation efforts. Widespread concern for post-earthquake fire and hazardous materials is too recent, relative to other better-known problems, for special mitigation techniques or solutions to have evolved, with the exception of the US in the city of San Francisco, where a highly developed and unique auxiliary water supply system has been developed, as a result of the 1906 earthquake and fire. The situation in Japan, with regard to hazardous materials, is similar, while the post-earthquake fire problem in Japan has produced solutions along the lines of San Francisco's.

It was pointed out that hardware solutions are needed for both fire and hazardous materials. Furthermore, in Japan an attitude appears to prevail whereby efforts are put more into development of fire barriers and methods of evacuation than into trying to prevent fires which cannot be prevented. These points were discussed by Okamoto and Miyagawa.

On a preliminary basis, there appeared to be a fundamentally different approach, based on different conditions, between the US and Japan. In the US the stress is on pre-event prevention of the problem, while the Japanese approach appears to be oriented more towards response and avoidance of what is seen as inevitable.

HAZARDOUS MATERIALS (HAZMAT)

The discussions of the second day were solely concerned with hazardous materials and fire following earthquake. These discussions, during Working Group 4, were too complex and fast-moving to permit any but summary review here, or to allow accurate attribution of specific points (readers are referred to the Workshop Papers and Issue Abstracts). Rather, a structure emerged in the discussions, which this summary repeats, where the following three points were addressed:

- What is the state of the art?
- Is this state satisfactory? and if not, what is required for its advancement? and
- How can the items required for advancement be achieved?

These points were addressed, where possible, from the following aspects of both hazardous materials and fire:

- Data
- Analysis
- Dissemination
- Mitigation

This section reviews the discussion with respect to hazardous materials, according to this structure, while the next section similarly addresses the problems of fire following earthquake.

Data

Discussion indicated that relatively few hazardous materials-related incidents have been documented from past earthquakes. Some incidents have been recorded in the course of documenting fire department operations, but - great detail was not captured. The recent I October 1981 Whittier Narrows earthquake in southern California, in which a major chlorine release occurred, has been better documented. Because of this situation, analysis and development of mitigation approaches has to rely on nonearthquake hazardous materials experience. In the US, California has started collection of all hazardous materials-related incidents, beginning in January 1988. Japan has been collecting information for some time. A need was indicated for a uniform, centralized data collection protocol. Recently, legislation has been enacted in the US to achieve this, but its acceptability is yet to be seen.

With regard to earthquake-related hazardous materials incidents, there is little US data, and only a slightly more in Japan, as discussed above. An emphasis on post-earthquake investigations and research is needed, in this area, as well as standardized post-earthquake data collection protocol.

Another major area is the inventorying of hazardous materials storage and related data. Japan has already made an inventory of flammables, while other types of materials are currently being inventoried -- a process will be finished by about 1991. In the US the data exists although it is not fully centralized. Two needs were identified here: (a) Transfer of the inventory information to earthquake damage users; and (b) coordination between various agencies:; and jurisdictions, with regard to existing inventories.

Analysis

Consensus was fairly clear that fault tree analysis (FTA) methods (using the term generically) are the appropriate route for incident simulation and damage estimation. The most useful analytical aids are hard copy maps and lists. While FTA is the best course to pursue, assessment of present methods as well as future developments are still needed. Another very important need is for an inexpensive PC-based geographic information system (GIS), for research, planning, and response. Achieving these goals clearly requires some commitment of resources.

Dissemination

Dissemination of the results of fires and hazardous materials following earthquakes has been poor in the US, but somewhat better in Japan, although recent US efforts, such as the pilot training courses conducted by the Bay Area Regional Earthquake Preparedness Project (BAREPP), the Southern California Earthquake Preparedness Project (SCEPP), the Association of Bay Area Governments (ABAG) and others are improving the US situation. So-called "pipelined" research (i.e. , focused research with close user/researcher cooperation) is a major feature of the Japanese scene, which definitely enhances dissemination and utilization of research. In the US, end users and researchers are often relatively far apart.

Better analytical results are a must, to improve dissemination, as well as increased government sponsorship and involvement.

Mitigation

Mitigation can take place in several ways. Education with regard to hazardous materials is apparently effective in Japan while less than satisfactory in the US hardware approaches to real-time modeling and optimization of responses are feasible, in that the technology exists, although it is not fully validated. Wider application is required here. The emergency response aspect of mitigation is unsatisfactory, in that given a typical post-earthquake environment rapid saturation and overwhelming of emergency response facilities are likely. Additionally, there is relatively little experience in post-earthquake hazardous materials-related emergency response. More training and resources are required here, which will probably only follow after better dissemination of analytical results.

FIRE IMMEDIATELY FOLLOWING AN EARTHQUAKE

Data

There are three aspects to data relating to fires following earthquakes: inventory, ignition, and spread. Inventory refers to readily accessible information regarding buildings, occupancies, and contents for purposes of modeling and emergency response planning. Building inventories are relatively well detailed and available in Japan, but these present a major problem in the US, where usable inventories are almost entirely lacking. The situation is particularly frustrating in the US since detailed information exists in the form of building department and assessors' files, and insurance (Sanborn) maps, but these are either not electronically formatted (insurance maps and building department structural information) or are of low reliability (assessors' files). A major effort is, therefore, required to improve the inventory situation. This effort should involve development of a cost-effective inventory methodology and assignment of responsibility for jurisdiction-by-jurisdiction inventory compilation. Fire departments are candidates for this responsibility, although the feasibility of this requires further investigation.

Post-earthquake fire ignition data and experience have been fairly well documented both in Japan and the US. Questions remain of course, but this area does not appear to be a major knowledge gap at present. Extrapolation of this data to estimation of future ignitions is a larger and more complex question.

Fire spread in general is a major problem. Significant work has been carried out in Japan, and present US methods for estimation of post-earthquake fire modeling rely on the Japanese work. More work in the US in this area is undoubtedly desirable.

Analysis

The problem of post-earthquake fires has received quite a lot of attention in Japan, and several methodologies have been applied and form the basis for planning and response. In the US, the situation is somewhat less developed, with only one methodology currently available. Further validation of the existing methodologies is required, both in Japan and the US, as well as a transfer of the methods and results, to user agencies (i.e. , fire departments).

Dissemination

The results of post-earthquake fires modeling and their dissemination in Japan is good, but only minimal in the US, although recent efforts have improved the situation. Government involvement is required in the US to further improve the situation, through closer user/research cooperation (“pipelining"), as well as increased state and federal attention to the problem. Lastly, simplified models for employment by end users is needed, for dissemination purposes as well as increased confidence on the part of end users.

Mitigation: US

In the US, mitigation of the post-earthquake fires problem is in a sorry state. Generally speaking, water supplies have not been examined for post-earthquake reliability and functionality, by owner agencies. Studies are needed here to provide simplified but reliable and cost-effective methods for reliability determination and identification of weak links. Support for this can be achieved by increasing the awareness of local fire and water departments.

Ignition prevention is currently not addressed in the US, with the exception that most people know that they should turn off the gas following on earthquake (although many don't clearly understand why). The Whittier Narrows earthquake, a TV station went on the air advising residents to turn their gas off, with the result that 25,000 customers did so, many needlessly so, according to the local gas utility. Several weeks were required to safely re-light all of these customers. Ignitions may be very amenable to prevention by new and improved hardware currently coming on the market (e.g. , automatic 'gas seismic shut-off valves). Several manufacturers are presently bringing these devices to market, and should be encouraged.

Suppression of fires in the minutes following a major earthquake is obviously a vital step towards mitigation of the post-earthquake fire problem. In the US, Los Angeles is the only city currently training citizens to be adequately prepared for this. Other jurisdictions should be encouraged to follow this excellent example. Lastly, the professional fire departments are the obvious main link in preventing conflagrations following earthquake occurrence. Few jurisdictions have conducted surveys to determine the structural adequacy of their fire stations, dispatch centres and other key emergency- response facilities. This should be strongly encouraged, even mandated.

Mitigation: Japan

The situation in Japan, vis-a-vis that in the US, is somewhat better. Citizens are well aware of the problem and have often received some training. Urban planning incorporates consideration of post-earthquake fires to the extent of designating selected corridors as firebreaks and/or evacuation routes, with corresponding mandated fire protection features.

Communication of fire reports in Japan, like the US, still relies on the telephone system, which is known to be unreliable. The emergency number in both countries (911 in the US, 119 in Japan) should be programmed for priority, to the extent feasible, and this should be required. Additionally, in Japan the size of the post-earthquake demand on fire department resources is not widely appreciated. Wider dissemination of reliable damage scenarios should be a goal supported by government efforts.

Lastly, in both countries, safety conditions regarding post-earthquake fires in high-rise buildings are relatively unknown but probably low due to the inability of the fire departments to respond. Better post-earthquake functionality of fire/life-safety systems should be mandated. The question of post-earthquake occupant behaviour in high-rise buildings is also important and requires further research. Competing needs i.e., (a) of maintaining a presence for fire detection and suppression, while (b) needing to evacuate persons from upper stories before they may be trapped there by fires on lower floors, require resolution. Training for evacuation from selected portions of high-rise buildings to places of refuge (often still within the building) is a high priority need.

2-5 WORKING GROUP 5 : SHORT-TERM EMERGENCY RESPONSE

ORGANIZATION OF THE SESSION

Working Group 5 included presentations from sixteen participants. In order to provide time for questions, discussion, and synthesis, presentation time was severely limited. Total time for each presentation including discussion was restricted to twenty minutes. With this schedule rigidly enforced, the Working Group heard from each speaker and was able to arrive at some consensus on statements relating to: .

-State of the art
-Problems
-Further research

The progress of the Working Group was possible only with the cooperation of all participants and the excellent bilingual ability of Professor Selvaduray.

Working Group 5 met first in a joint session on Wednesday with Working Group 6 (Long-Term Recovery/Reconstruction). It then met again on Thursday on its own to conclude presentations and to discuss remaining problems and collaborative research interests.

On Wednesday afternoon, the joint session with Working Group 6 began with a brief introduction to emergency response issues presented by co-chairperson Krimgold. Presentations selected from Working Groups 5 and 6 were then delivered. These presentations were organized under five headings:

- Disaster Experience
- Response Planning
- Recovery Studies
- International Decade for Natural Disaster Reduction (IDNDR) (Special Presentation)

On Thursday, presentations continued in a session including only the members of Working Group 5 . Presentations for Thursday were organized under the following headings:

- Administration
- Information Systems
- Response Activities
- Rescue

STATE OF THE ART

It is not clear whether or not it is possible to provide a final statement concerning the "state of the art" from the material presented in the session. Some concerns were voiced by the participants that the structure of the sessions in the workshop was somewhat awkward. It was felt that the subject matter of Working Group 5 was more closely related to that of Working Group 4 than to that of Working Group 6. The following are general summary statements on progress to date under the topic headings of the presentations.

Disaster Experience

Presentations included reports on the 1987 Chiba earthquake and the lzu-Ohshima evacuation. Both cases were in Japan and demonstrated a high level of organization and response capability for coping with natural hazards. In the Chiba earthquake, the most important factor was nonstructural damage. In the lzu-Ohshima pre-eruption evacuation, an important aspect was economic impact estimation.

Response Planning

Presentations from Japan and US were made, focusing on plans and planning processes. While it appears that plans for specific infrastructure systems (Tokyo Gas) are well developed in Japan, there is still a need in both the US and Japan for improved approaches to interjurisdictional planning. There is also a danger of hierarchical discontinuity between planning functions at various levels of government, i.e. , city, prefecture, and national.

Recover Studies

One US presentation was made under this heading. Emphasis was placed on the structure and limitations of local public sector response in the US. Local public sector response must be coordinated with private sector actions, individual actions, and the actions of surrounding localities as well as state and federal government.

Information Systems

Two presentations from Japan were made on this topic. Real time information systems have been developed to assist in major fire response and proposals are now being made for wider applications of similar systems for other types of disaster response. These systems require real time input of event location and intensity distribution. They also need up to date physical data on structures and urban systems as well as response capability. The systems are based on empirically derived algorithms which relate intensity to damage and other types of impact. Impacts are then translated into response demand and the system can provide nearly instantaneous response plans tailored to the event, locality, and response capability for which it is designed. The systems reported are still under development.

Rescue

Two Japanese presentations were made on the topic of rescue. One was a proposal for a rescue ship for foreign disaster assistance in the islands of the Southwestern Pacific; the other reported on the types of volunteer activity in specific events. While these presentations did not define the state of the art, they did raise interesting questions about possibilities for improvement of the rescue functions. Little effective use is made of volunteer manpower in disaster response plans at present in either the US or Japan. The international rescue problem is getting considerable attention in the media in both the US and Japan.

PROBLEMS

After the presentations were concluded, the discussion of the Working Group was focused on remaining problems. There was a great deal of discussion of cross-cultural comparison, particularly addressing underlying issues which relate to differences in the US and Japanese approach to similar problems.

A basic problem relates to the feasibility of US and Japanese exchange on the topic of terminology. In many instances, simple translation of terms did not adequately communicate meaning. In some cases, terms which appear similar in fact refer to very different cultural antecedents or simply different structuring of the same problem. To illustrate this problem, the working group compiled a short list of terms dealing with concepts which are not clearly understood in translation:

- Hazardous Materials
- Disaster
- Emergency
- Disaster Damage -- ranking of disaster impacts
- "Bousai"
- Urban Search and Rescue

US distinctions among the following groups of terms are not clear for Japanese:

- Recovery, Reconstruction, and Restoration
- Function and Activity
- Lifeline and Infrastructure
- Security and Safety
- Urban Search and Rescue
- Civilian

It was suggested that an annotated terminology list should be prepared by a group knowledgeable in both US and Japanese usage. Many concepts do not have single word equivalents in the corresponding language.

Another basic issue addressed in discussion was the relative importance of the earthquake" threat in the US and Japan. The feeling of the group was that earthquakes are a major national concern in Japan, but not in the US. It was mentioned that even at the regional level, i.e., California, earthquakes are not taken as seriously as in Japan. Earthquakes are a central issue in Japan, but not in the US, even in California. This makes comparisons of public response more difficult or less meaningful.

Another basic difference between the US and Japan is the basic character of the Japanese settlement patterns in seismic areas. In Japan there is a lot of experience of dense wooden settlements being destroyed by fire following earthquake. That is not the US experience (apart from 1906). Fire-fighting and evacuation are a major part of Japanese response planning. To date, they are not a major part of US response planning.

Aside from these issues, the Working Group assembled the following list of important issues:

- Lack of interjurisdictional planning (US);
- Lack of effective rationale for funding emergency response planning (US);
- Lack of cooperation between agencies (Japan);
- Inconsistency of citizen expectations and government commitment (US);
- Citizens' over reliance on local government leadership (Japan);
- Technology transfer --research to application;
- Mobile populations in disasters --i.e., tourists, students;
- Needs of special populations, i.e., handicapped, elderly;
- Development of damage assessment methodologies related to specific functional response;
- Potential integration of damage assessment data bases;
- Concern for public and private liability in emergency response (US);
- Intermingling of war (nuclear) preparedness with natural disaster preparedness (US);
- Lack of citizen training in basics of first aid and response actions (US);
- Emphasis on institutional responsibility --expectation that safety is guaranteed (Japan);
- Information transfer from government to public;
- Concept of individual rights complicates role of authority (US);
- Multilingual culture complicates disaster communication (US);
- Training and equipment for large-scale urban search and rescue (US);
- Training and organization for civilian handling of mass casualties and mass care (US);
- Communications between medical and health care facilities during response (Japan);
- Blocking of transportation routes by abandoned vehicles and loss of traffic signals (Japan);
- Overload of telephone system after disaster (US and Japan);
- Effective use of land-use regulation for risk reduction;
- Lack of fire zonation in US;
- Social behaviour patterns complicate response, i.e., individualism in US and conformity in Japan;
- Implications of earthquake effects on nuclear power stations (Japan);
- Survival training in the work place --private sector mitigation planning and response planning; and
- National awareness -- geographical extent of media coverage.

FURTHER RESEARCH

On balance, the Working Group found the session to be quite valuable. It was found that many research issues were of common interest and that many topics lent themselves well to US/Japanese collaborative research efforts.

The following list was compiled on the basis of group discussion. Time did not allow the structuring of the list or the indication of group prioritization:

- Identification of items that should be surveyed when an earthquake occurs;
- US-Japan exchange of technology and information (including operational agencies);

- Use of "sister city" links for continued emergency and disaster preparedness exchange programme;
- Comparative studies of risk perception related to countermeasures in the US and Japan;
- Comparative study of public education specifically related to disaster response;
- Development of techniques for regional (interjurisdictional) response planning;
- Collaborative research and development of real time information and management systems;
- Exchange of software, unification and adaptation of systems for response management;
- Joint studies of evacuation and evacuation planning;
- Joint research on search and rescue in collapsed buildings;
- Organization of data bases of past incidents (including successful cases with no damage);
- Joint study of social and psychological impacts of disasters;
- Economic impact studies on recovery, GNP, and the industrial structure;
- Joint study on the problem of computer backup after an earthquake;
- Comparative study of emergence and function of volunteer groups;
- Joint development of evaluation criteria for the effectiveness of various categories of response;
- Methods for providing emergency information to the public;
- Studies of risk management --comparative studies of private sector risk management;
- Development of a specialized multilingual glossary of disaster related terminology;
- Establishment of disaster preparedness libraries --one in each country --with a comprehensive information retrieval system, including non-technical literature;
- Identification and pairing of corresponding organizations with parallel functions in the US and Japan, including research and implementation organizations;
- Studies of the distribution of public mitigation and preparedness costs and related revenue generation methods; and
- Comparative study of assignment of public agency disaster response responsibilities and training procedures related to response functions.

CONCLUSION

The participants voiced a general feeling that the session had been very valuable. It was considered very useful and important to bring together both researchers and local officials in this sort of meeting. Reports on the state of practice in disaster response and disaster response planning were very useful for both researchers and officials. It was also considered important that Japanese and American officials and practitioners were able to exchange information as they have few opportunities for such contact. There was interest expressed in finding a way to provide more frequent opportunities for interactions. Four years was considered too long a period between meetings.

2-6 WORKING GROUP 6: LONG-TERM RECOVERY/RECONSTRUCTION

INTRODUCTION

Working Group 6 discussed issues of long-term recovery and reconstruction. These are items that take longer to accomplish than short-term emergency recovery issues discussed by Working Group 5.

Working Group 6 heard a series of interesting and informative presentations that formed the basis of our discussions. These presentations were generally in categories of planning, earthquake hazard assessment, structural evaluation, and repair and strengthening of structures.

The discussions of Working Group 6 can best be summarized by grouping comments in three general categories. First are comments related to Detailed Damage Assessment after an Earthquake. Second are comments regarding Mitigation Measures while the third category deals with Reconstruction Planning.

DETAILED DAMAGE ASSESSMENT AFTER AN EARTHQUAKE

Following a significant earthquake, various types of damage assessments are necessary to document the damage and lack of damage and provide a basis for mitigation and planning. An initial limited damage assessment is made to determine the safety of buildings and structures for continued occupancy or use and determine where more detailed damage assessment is required. This initial limited damage assessment, which includes the posting of structures, was discussed within Working Group 5 and is not covered here.

Detailed damage assessment was divided into two subcategories, direct and indirect damage. Assessment of direct damages includes detailed review of damage to structures and lifelines. This assessment is performed by engineers usually for the property owner with results being provided to the appropriate government agency. The results usually include repair and strengthening recommendations to mitigate the damage. It was agreed that guidelines and manuals for detailed damage assessment of buildings, bridges and lifelines are most important to give guidance to the engineers performing the damage assessment. Many such documents already exist in both Japan and the US. Documents not yet prepared to give guidance should be done in the near future. However, it was agreed that even with documents that have been prepared, most engineers are not familiar with their contents and their use. It was agreed that a major educational effort is needed in both Japan and the US to help engineers understand the guidelines and manuals so their judgment will yield more consistent results.

Indirect damages include social, psychological, and economic damages. These are often difficult to define, as few investigations have been conducted in either the US or Japan. Knowledge of the extent, duration, and severity of indirect impacts is, as a result, still far from complete. Detailed assessments of indirect damages are necessary to improve future building codes and to anticipate economic impact, including loss of businesses and other economic functions, and to better understand social issues relative to reconstruction.

MITIGATION MEASURES

The topic of mitigation measures not only includes the basic technical issues of repair and strengthening of structures but also those related to land-use planning and other issues. While it may be fact that mitigation measures to improve the seismic performance of structures is a post-earthquake activity, it was agreed that in both the US and Japan the majority of strengthening work for improved seismic performance is performed without an earthquake but as part of long-range planning efforts.

Guidelines for repair and strengthening of some types of buildings, bridges and lifelines have been prepared in Japan. In the US, guidelines for building strengthening have not yet been prepared but CalTrans (California Department of Transportation) has prepared guidelines for bridge strengthening. It was agreed that guidelines in this area need to be completed and expanded and educational efforts on their usage are needed. Guidelines of this type must be somewhat country-specific to deal with the actual types of construction that will be encountered.

The issues of strengthening raised many policy issues, especially when strengthening of structures is performed prior to an earthquake in anticipation of an event. When should buildings be strengthened? To what criteria? Who will pay the cost? Should there be governmental or tax incentives to perform such work? How should it be done when buildings or structures are fully occupied or in use? What are the priorities? What are the responsibilities or liabilities when structures are identified and studied but not strengthened before the earthquake? What are the reliabilities of various techniques? It was agreed that all of these related issues need to be studied in detail in both Japan and the US and the mutual exchange of ideas and solutions would be beneficial to both countries.

Land-use planning based on careful hazard mapping is also an essential aspect of earthquake hazard mitigation. Japan has performed several land-use studies after earthquakes, particularly relative to force and trying to rebuild cities to prevent the rapid spread of fires. After one earthquake, the damaged Japanese community imposed a two-month moratorium on repair and strengthening to allow land-use planning to be completed. Realistically, such planning should be completed prior to any earthquake so implementation can follow immediately after the event.

Education and training compose a third aspect of mitigation. Discussion suggests that guidelines need to be developed in both countries to provide more effective public education and professional training.

RECONSTRUCTION PLANNING

Reconstruction planning should be prepared and in place prior to the occurrence of an earthquake. Following an earthquake, there is a need to validate the plan against the effects of the earthquake and adjust the plan as needed. The City of Los Angeles is in the process of preparing a reconstruction plan and the Working Group found the City's efforts most interesting. There is no other reconstruction plan in existence or in development in Japan or the US. It was agreed that such plans are of great importance and the efforts of the City of Los Angeles will be followed with interest in both the US and Japan. It was also agreed that such plans are very difficult to formulate due to the difficulty in predicting damage and the impact of an earthquake in the area. Research has identified some of the problems which must be addressed in such plans, an example being fire prevention plans in Japanese communities.

It was agreed that it is highly desirable to have Reconstruction Plans in place prior to an earthquake. However, there are many problems to solve in preparing such plans. There is a need to develop criteria to validate the plan after the earthquake, based on actual damage. Such plans are important for prompt recovery, and they should be coordinated with other plans in the area. It was agreed that agencies should be encouraged to establish such plans.

FUTURE COOPERATIVE EFFORTS

It was mutually agreed that cooperative research and exchange of ideas and methodology between Japanese and US experts in the field will be extremely beneficial and should be encouraged. Each country should continue research relative to post-earthquake recovery, continue guideline development, etc., and exchange ideas and information. Guidelines for damage assessment and repair and strengthening should be jointly refined and extended to other parts of the world as part of the International Decade for Natural Disaster Reduction (IDNDR).

3. ANCILLARY PROGRAMMES

3-1 NAGOYA MEETING

26 (Tuesday) Jul 1988

Before the main session at Shimizu, a small meeting was held at UNCRD, Nagoya, attended by twelve participants. First, Sazanami, Director of -UNCRD delivered an opening address, in which he focused on two points:

- UN General Assembly approved the International Decade for Natural Disaster Reduction (IDNDR); and
- Early meetings of UN working group are taken up by selection methods/ selection of UN experts for each area of disaster (earthquake, floods, typhoon, etc.).

Against this backdrop, the activities of UNCRD are then broadly sketched out.

- Preparatory work for Seminar aimed at disaster prevention studies and research;
- Groundwork for setting up an International Centre for Regional Development Planning for Disaster Prevention (ICRDPDP);
- Continue organizing international seminars/expert meetings; and
- Support/promote the IDNDR activities both in Japan and the developing countries.

Regarding the latter area it was noted that UNCRD aims to promote the setting-up of data bases, study and research, and training and education in each field established by UNCRD. A principal task in this connection is the realization of a comprehensive set of disaster prevention counter-measures integrating the natural and social sciences. It was hoped that at the current seminar valuable pointers as to how this may be achieved, would be forthcoming. It was a crucial issue. A principal UNCRD function is dissemination of research output, to distribute information, thereby increasing awareness among concerned agencies. Sazanami emphasized that UNCRD sought advice on how to improve the current level of UNCRD'S activities.

The meeting proper then commenced, with Arya acting as chairman. The task, as outline by the chairman, was then to be a presentation by each participant as to the type of activities undertaken by his country/ institution in the field of disaster prevention and management, and importantly, what views or advice could be given to boost UNCRD'S activities in relation to the IDNDR.

Arya noted, as a guideline, that perhaps each participant could couch his observations/advice to UNCRD within the context of his own country's ongoing disaster prevention projects. There was the additional viewpoint that this kind of project needs to be regional (natural disasters respect no international boundaries).

Gupta, of the Asian Disaster Preparedness Center (ADPC), Bangkok, then provided some valuable information on the type of activities undertaken by his centre.

- Disaster management courses undertaken at the centre, embodying technical, social, and managerial aspects. Political aspects are left to the countries concerned. These are biannual courses.

- ADPC also ran in-country courses and assisted those countries which wanted to replicate ADPC's courses (seismic design courses in the Philippines, etc.).

In-country programmes run in Sri Lanka collaborating with UNDRO. ADPC is concerned with training, though as yet no research faculty. No overall strategy for the IDNDR, but many countries have approached ADPC for help in preparing their own IDNDR programmes. The ADPC is currently preparing training courses on "single disaster occurrence" (mitigation and repair). He reserved comment on UNCRD'S activities till later.

An additional point of information was supplied by Arya who outlined the UNESCO courses (in Bangkok) on school building safety. He noted the importance of visits to an actual disaster site, education, training, and retraining are important.

The case of Egypt was presented by Hamada from the Faculty of Engineering, Cairo University. He described the twenty-one-station network of seismic stations in the country. His faculty's principal activities centred on the study of earthquakes in cooperation with the planning ministry. An earthquake code was not yet established. In conjunction, earthquake training seminars of two weeks duration are held in collaboration with UNESCO, at Helwan. A Computer Centre has been set up at Aswan, to analyse seismograph output. Much enthusiasm, but there was a need to establish a national code. The seminars were on earthquake engineering, principally for technical operators, with participants from North Africa and the Middle East.

The case of Indonesia was represented by Dradjat Hoedajanto of the Civil Engineering Department of Bandung Institute of Technology. The speaker was chairman of a working group to renew concrete codes, and voiced his private views of the problems:

- Difficulty in code-setting;
- Lack of problem-awareness by people with capacity to make decisions;
- No chance for trainees in structural engineering to implement what they learn; and
- Poor conditions, borrowed research.

Bandung Institute received assistance from Japan International Cooperation Agency (JICA), but the Building Research Centre had limited capacity, and still no capacity for research. Arya noted that UNCRD could conduct joint training/research programmes in the same way as JICA. The whole picture of Indonesia seemed to indicate a generally low level of human capability.

Following the recess, Harry Kim of the Civil Defense Agency of Hawaii presented his case. The wide range of natural disasters likely to effect Hawaii has led to the Agency being very centralized/authoritarian. Civil Defense Agency directs and coordinates all stages -- pre-, mid-, and postdisaster measures. Suffers from lack of expertise, difficulties in working with natural scientists; need for data base on potential hazards/ disasters; obvious need for more international cooperation. The structure of the Hawaii Civil Defense Agency is issued by UNESCO as a textbook example. The Agency acts as a centre for scientific data. Fixed administrative personnel is small, though in times of disaster, all manner of other resources are placed at the Agency's disposal. During nonemergency times the Civil Defense Agency is concerned with monitoring and prevention/mitigation measures. Training is continually updated. Preparation work (tsunami evacuation, etc.) is continuous. Mapping and evacuation data constantly are checked. Actual training exercises periodically are undertaken.

Lara-Rosano then presented the case of Mexico, which, following the 1985 Mexico City Earthquake, had created a new agency which had a wide range of activities including external and internal programmes:

- Organization of the International Centre for Disaster Research, on the campus of the University of Mexico;
- Organization of training and participating activities; and
- Cooperation with U.S.A., with establishment of two commissions, for hurricanes and earthquakes.

Internal programmes included:

- Strengthening the resilience of Mexico City against disasters; and
- Reconstruction programmes for housing and social facilities.

The National University of Mexico conducts interdisciplinary programmes for disaster research, a number of faculties collaborate (architecture, law and engineering) . Research programmes, into methodology, systems analysis and systems design are being conducted. Regional plans (organizational , civil defense planning , hurricane mitigation, and social systems, etc.) are also being drawn up. Following the 1985 disaster agent deal of foreign financial support was generated.

From additional questioning it was ascertained that the proposed research centre was not yet operational. Regarding investment, and what kind of assistance was most useful, it was mentioned that there was short-term investment, for rescue measures, medical assistance, etc., and long-term assistant for renovation and rehabilitation measures, training schemes, and warning devices. The government tended to regard private organizations with suspicion. Money from abroad was useful in setting up long-term programmes of training and investment.

The case of Yugoslavia was represented by Mihailov from the Institute of Earthquake Engineering and Engineering Seismology at Skopje. He noted that 95 per cent of all research/training on earthquakes in the country was carried out here:

- Training/teaching was important with Master's, Doctor's, and Special courses for developing countries, offered in earthquake engineering and seismology. Other courses were conducted for architects, urban planners, etc. Periodic seminars/short courses on specific areas such as monument survival and old-town reconstruction.

- Research, covering a very wide area, is conducted. Disaster prevention techniques; design code investigation; microzoning maps; building strengthening research; soil dynamics; and vulnerability codes. Joint research with many nations is carried out, i.e., assistance to revise seismic codes; setting up strong motion networks; seismic risk reduction, etc. Numerous co-projects with foreign countries, governments and/or universities.
- Collaboration with UN agencies such as UNESCO, which provides equipment and pays salaries of visiting professors. UNCHS (Habitat) supported activities in Mexico. Surveying for Trans-European Highway assisted by UNESCO.

For the IDNDR, special seminar preparation was underway, and special research into technological consequences of earthquakes. Speaker reserves comment on UNCRD activities.

In Peru, the situation was presented by Ottazzi, associate professor in the Department of Engineering, Catholic University of Peru, who concentrated on an outline of his own work, rather than giving the national context. Low-cost housing which incorporated earthquake resistance was his area of concern. Revising the national building code to incorporate reinforcement systems, moisture resistant materials, other areas of concern. How to disseminate results of research was a problem -- pilot projects utilized but so far unaccepted. How can people be convinced to use new technology? Japanese technical assistance was being provided to the University to construct modern seismology laboratory. Training, in Peru and Japan, by JICA, and other collaboration in the area of microzonation. No earthquake since 1974 so awareness and preparedness is subsiding. Sazanami noted that landslides were a perennial problem.

Punongbayan, Director of the Philippine Institute of Volcanology and Seismology, gave a brief outline of the Philippines Case.

Monitoring	←Document	→Disaster Preparedness plan/Policies
Forecasting	→Basic Studies	Loss prediction
Warning		Relief
Response		Rehabilitation

A number of institutions exist for specific types of disaster, though improved coordination is essential. Damage-estimate maps drawn up; risk maps; awareness elevation among inhabitants has high priority;

Dissemination of information	media	
policymakers		
	institutions	
development planners		
	organizations	
researchers		
	education system	students schoolchildren/communities

Local inhabitants are involved in observing natural phenomena, -- associated with volcanoes. Good relation with media is maintained. Shortage of seismic stations is noted (twenty-one active volcanoes, only five monitored).

Kaji then presented the case from Japan. As a professor from the Institute of Socioeconomic Planning, at the University of Tsukuba, he had worked in three areas of disaster prevention.

- A member of SPA committee, overseeing disaster prevention measures in Tokyo metropolitan area (damage estimates, vulnerability, etc.). Four working groups covering Seismic damage; five hazards; construction; and social work.

- Ministry of Construction, in establishment of real-time information system (software and hardware). This is projected to be a five-year undertaking.

- Consultant of Tokyo Fire Department, work involves real-time information processing for firespread; training for citizen's self-help/relief organizations. Four thousand civil groups already organized, though operationalization is difficult. Training tool development, evacuation exercises, how to maintain levels of commitment and motivation during times of nonemergency.

Several questions concerned were raised:

- Media involvement: There was a close network between the government and the media; a telemetry system was utilized.

- Citizens' organization: This was carried out on a neighbourhood basis, with election of local leaders. A manual containing operation details has been produced. Trials/competitions maintain citizen awareness.

- High rate of literacy, TV/radio ownership guarantees dissemination and comprehension of information. Battery radios and sirens are utilized during alarm situation.

Chairman Arya then outlined the situation in India. A gamut of potential disasters exist; floods, cyclones, earthquakes, landslides, etc. Civil Defence preparation is minimal, although cyclone shelters are being built, and embankments are under consideration, National network of seventy seismological observatories in place, under jurisdiction of Department of Science and Technology. A principal problem was nonengineered structure vulnerability; there was a large training requirement , need for international collaboration , additional resource personnel. It was observed that few countries of the region have advanced very far in this area, largely due to greater concerns (floods, etc.). The government of India is active in preparation for the IDNDR, an earthquake committee has been set up. Too many ministries to approach for assistance (India has fifty-two) -- perhaps cabinet secretary-level is better. The South Asia Association for Regional Cooperation (SAARC) may be a useful forum to approach for support.

The meeting then adjourned.

3-2 OPEN FORUM

29 (Friday) July l988
l:30 p.m. to 4:00 p.m.

An Open Forum was convened for the purpose of discussing issues and problems in disaster prevention and management, and people's collaboration against disasters, organized by the Institute of Social Safety Science (ISSS), Japan. The forum was focused on the earthquake risk which the Tokai region around Shizuoka Prefecture faces, called "Tokai Earthquake" hazard risk.

N. Kawabata from Shizuoka Broadcasting Company coordinated the forum and six panellists presented their views on issues related to earthquake hazard risk: M. Ino, Shizuoka Prefectural Government, Japan; R. K. Eisner, Government of California State, U.S.A.; S. P. Gupta, Asian Institute of Technology, Thailand; K. Tokuda, Committee of Promotion of Self-Disaster-Prevention's Activities in Shizuoka Prefecture, Japan; F. W. Borden, Fire Department of Los Angeles, U.S.A.; and S. Yokouchi, Chubu Electric Company, Japan.

Firstly, Ino presented an outline of organizations of self-disaster-prevention in Shizuoka Prefecture, which were resident voluntary organizations against disasters, especially the pending "Tokai Earthquake." He explained the establishment and activities of such organizations through the example of Oigawa-cho. Shizuoka Prefecture, and activities of the organizations became the bases of the concerned community formulation.

Eisner's presentation was focused on the information dissemination concerning earthquakes, especially issues and problems on earthquake warnings. After pre-shocks as a precursor occurred, it had to be decided when an earthquake warning would be issued; it was necessary to deal with an announcement of an earthquake warning quickly. For the announcement of earthquake warning, the following items were needed: Collecting accurate data on prediction of earthquakes; analysing pre-shocks and after-shocks; communicating closely among scientist and researchers; collecting, processing, and disseminating information on earthquakes accurately and quickly; announcement of earthquake warning, and training and education on warning; and disseminating information to general public accurately.

Gupta gave a presentation centred on the general measures against disasters, which consisted of pre-, mid-, and postdisaster measures, through the examples of India and the Philippines. He expressed that enough preparedness measures would limit damage to a minimum, and these measures included issues as follows: Land-use planning and microzonation; building design code; strengthening, reinforcing and repairing for existing buildings; and raising awareness of the general public, training, and education.

Tokuda also presented an outline of organizations of self-disaster-prevention in Shizuoka Prefecture and their activities from the viewpoint of the chairman, self-disaster-prevention in Shizuoka Prefecture, and the chairman, Funakoshi-higashi-cho Self-Disaster-Prevention Organization. Aims of the organizations were: To protect the people's lives and properties against the expected Tokai Earthquake hazard risk; and to mitigate damage following the earthquake. Activities of those organizations are mainly focused on pre-disaster measures, such as family preparedness in individual houses, training, seminars, etc.

Borden focused on the disaster prevention measures of the Fire Department of Los Angeles. The measures were developed through various planning and programmes, and dealt with the growing potential disaster occurrence . Therefore, in the Office of Disaster Management, Fire Department of Los Angels, four units were established to implement the measures: Community Department Preparedness Unit; Research and Development Unit; Community Response Team Unit; and Fire and Safety Education Unit.

Yokouchi's presentation was focused on the issues which consisted of: What countermeasures Chubu Electric Company should implement against the expected Tokai Earthquake hazard in the pre-, mid-, and postdisaster stage; disaster prevention and management system of Chubu Electric Company; countermeasures in case of declaration of warning against the Tokai Earthquake; damage assessment of electric power facilities; and restoration and rehabilitation after the Tokai Earthquake would occur.

Several questions were raised following the six presentations. One related to the voluntary activities when an earthquake would occur. Discussion also took place on evacuation of the socially weak such as elderly, handicapped, etc. The others were related to information dissemination, Iiquefaction and building materials which would make poisonous gas in case of fire. Regarding these issues, there were some comments from Eisner, Borden, Tokuda, Ino, and Gupta. Following the discussions, Omachi, Associate Professor, Tokyo Institute of Technology, presented findings of the questionnaire survey of the difference of ideas for earthquake disaster preparedness between Japan and the US through some slides.

In concluding summary. Ino discussed the importance for people to defend their own area by themselves. This forum, which lasted for two and half hours, was concluded by a closing address by M. Hamada. Professor of Tokai University. About 150 people attended.

3-3 FIELD VISIT

29 (Friday) July 1988
4: 30 p.m. to 5:30 p.m.

Shizuoka Prefectural Government:
Countermeasures for Earthquake in the Tokai Region; and
Comprehensive Water Control Plans of Shizuoka Prefecture .

Since the so-called "Tokai Earthquake" hazard risk is said to be imminent in the Tokai region around Shizuoka, various countermeasures, including earthquake prediction are being implemented. In this field visit, the participants were given a briefing at the operations room on the Shizuoka Prefectural Government's Countermeasures against the Tokai Earthquake. The participants were also briefed on the comprehensive water control plans of Shizuoka Prefecture and on, among others, a monitoring system using advanced technology.

4. APPENDICES

4-1 PROGRAMME

NAGOYA MEETING

26 (Tuesday) July

10:00-13:00	Opening
Speech	H. Sazanami (Director, UNCRD)
	Main Session Chairman: A.S. Arya (Professor, Univ. of Roorkee)

SHIMIZU SEMINAR

27 (Wednesday) July

8:00-9:30	Registration
9:30-10:15	Opening Ceremony M.C. : M. Hamada (Professor, Tokai University)
Address	T. Katayama (Professor, University of Tokyo) L. A. Wyllie (Director, EERI)
Welcoming Remarks	S. Saito (Governor of Shizuoka Prefecture) Y. Yokoyama (Dean, School of Marine Science and Technology, Tokai University)
10:40-12:00	Plenary Session 1 Co-chairs: Y. Ogawa, C. Scawthorn
Plenary Addresses	"Regional Development Planning for Disaster Prevention and International Cooperation" by H. Sazanami (Director, UNCRD) "Earthquake Hazard Reduction: Technical Capabilities—U.S. Perspective" by V.V. Bertero (Professor, UCB) "Conceptual Discussion about Damage Estimation and Vulnerability Assessment by Earthquake" by H. Kaji (Professor, University of Tsukuba) "Earthquake Hazard Reduction: Society's Needs--A U.S. Perspective" by C. Arnold (President, BSDI)
13:00-17:30	Joint Group Sessions
18:30-20:30	Reception

28 (Thursday) July

9:00-12:00	Working Group Sessions
13:00-17:30	Working Group Sessions
18:30-20:30	Barbecue Party

29 (Friday) July

9:00-11:30	Final Plenary Session
	Summary Report by Each Working Group Chairman
	Closing Address by Prof. T. Katayama
13:00-15:30	'88 Shimizu Citizens' Forum on Urban Earthquake Hazard Reduction
Moderator	N. Kawabata (Deputy General Manager, SBC)
Panellists	F. W. Borden (Fire Assistant Chief, Fire Department of Los Angeles)
	R. E. Eisner (Director, BAREPP)
	S. P. Gupta (Professor, AIT)
	M. Ino (Director, Shizuoka Prefectural Government)
	K. Tokuda (Chairman. Committee of Promotion of Self-Disaster-Prevention' s Activities in Shizuoka Prefectural Government)
	S. Yokouchi (Director, Chubu Electric Company)

Chair Persons of Each Working Group Session

Working Group 1	P. J. Flores (Project Director, SCEPP)
	O. Arai (Director, National Land Agency)
Working Group 2	T. L. Tobin (Executive Director, CSSC)
	K. Suzuki (Professor, Tokyo Metropolitan Univ.)
Working Group 3	V. V. Bertero (Professor, UCB)
	H. Kameda (Professor, Kyoto Univ.)
	M. Hoshiya (Professor, Musashi Inst. Of Tec.)
Working Group 4	C. Scawthorn (EQE Inc.)
	M. Kobayashi (Lecturer, Kyoto Univ.)
	I. Tsukagoshi (Assistant Direotor, BRI)
Working Group 5	F. Krimgold (Associate Dean, VIPSU)
	T. lwami (Associate Professor, Univ. of Tsukuba)
	O. Koide (Associate Professor, Univ. of Tokyo)
Working Group 6	L. A. Wyllie (Director, EERI)
	K. Kawashima (Head, PWRI)
	A. Shibata (Professor, Tohoku Univ.)

4-2 LIST OF PAPERS

KEYNOTE PAPERS

Christopher Arnold, Urban Earthquake Hazards Reduction Society's Needs--A U.S. Perspective.

Vitelmo V. Bertero, Earthquake Hazard Reduction: Technical Capabilities -- U.S. Perspective.

Hideki Kaji, Conceptual Discussion about Damage Estimation and Vulnerability Assessment by Earthquakes.

Hidehiko Sazanami, Regional Development Planning for Disaster Prevention and International Cooperation.

PAPERS AT WORKING GROUP 1

W. Bakun and R.D. Borcherdt, Criteria for the Issuance of Public Warnings Based on Short-Term Earthquake Predictions Near Parkfield, California USA.

Paul J. Flores and Richard Andrews, Policy Implications of Earthquake Predictions.

Shirley Mattingly, Policy Problems of Earthquake Prediction: Local Government Policy Issues.

Vladimir Mihailov, Seismic Risk Reduction Through Urban Planning: The Yugoslav Experience.

Shuji Mukunoki. Japanese Earthquake Countermeasures: Current and Future Disasters.

Keiji Okamoto. Earthquake Measures in Urban Policy.

H.M.I. Sandi and S. Georgescu, Some Data on Earthquake Countermeasures in Romania.

Paul Somerville, Prediction of Damaging Earthquakes In Urban Areas: An Inverse Problem.

Toshiro Sugiyama, Countermeasures Against the Anticipated Tokai Earthquake in Shizuoka Prefecture.

Kazuo Tajima, Kawasaki City's Evacuation Measures.

Hiroaki Yoshii, Social Impact of Earthquake Warnings.

PAPERS AT WORKING GROUP 2

Richard K. Eisner, The Role of Regional Coordination in Public and Private Preparedness: Earthquake Preparedness in California

Edward S. Fratto, Earthquake Vulnerability and Estimation of Damage "User Needs ".

G.M. Hamada, M. Maamoun and S. Abdel Moatey, Impact of Earthquakes on Oil Wells in the Gulf of Suez.

Haruo Hayashi, Help Needed and Help Provided: The Case of the 1983 Nihonkai-Chubu Earthquake.

Kanji Kimura, Pictorial History of Disasters in Japan.

Randolph Langenbach, The Problem of Historic Preservation In Seismic Areas.

Tohru Miyazawa, Preparation for Tokai Earthquake in a Company.

Yujiro Ogawa, Protection of Cultural Inheritance from Urban Disaster.

Tatsuo Ohmachi, A Cross-Cultural Questionnaire on Earthquake Information and Its Implications.

Robert A. Olson Reverberations In Peru: Impacts of the Brady- Spence Prediction.

Jane Preuss, Assessing Vulnerability and Reducing Damage from Tsunamis.

Richard J. Roth, Jr., Insurance Experience and Exposure Regarding a Large California Earthquake.

Takashi Saito, Disaster Preparedness in Minato Mirai 21.

Yasuo Shioji, Disaster Preparedness Activities of Keihin Designated Area Disaster Preparedness Conference.

Kohei Suzuki, Earthquake Hazard Preparedness in Japanese Companies and Industries.

Thomas L. Tobln, Public and Private Earthquake Hazard Reduction In California.

PAPERS AT WORKING GROUP 3

Ahmet Emin Aktan, Seismic Vulnerability Evaluation and Upgrading of RC Buildings.

Haluk M. Aktan, Andrew S. Whittaker and Vitelmo V. Bertero, Non-Buckling Slip Braces for Seismic Rehabilitation.

Thalia Anagnos, Charles Scawthorn, Chris Poland and Chris Rojahn, A Methodology for Rapid Visual Identification of Seismically Hazardous Buildings in the United States.

Mehmet K. Celebi, Seismic Monitoring of Structures: A Necessary Element of Urban Earthquake Hazard Reduction Programmes.

Oris H. Degenkolb, Estimation of Earthquake Vulnerability Damage.

Satyendra P. Gupta Earthquake Vulnerability of Developing Asian Countries.

Dradjat Hoedajanto, Simple Model for Shear Response of R.C. Panels.

Hirokazu lemura, Yoshikazu Yamada and Akira lgarashi, Innovative Dynamic Control of Structures for Damage Reduction.

Hiroyuki Kameda and Nobuoto Nojima, Urban Seismic Risk Reduction: a Proposal for a Man-Facility System Model.

Noritaka Katatani, Current Computer Utilization in Prediction Methods in the Field of Disaster Prevention.

Masami Kobayashi, What is to Design Safety in Urban Structure?

Tetsuo Kubo, Evaluation of Seismic Performance and Retrofit of Reinforced Concrete Buildings in Japan.

Katsuhiko Kuroda, Land-Use Planning Under Natural Hazard Risks.

Felipe Lara-Rosano, Evaluation of Earthquake Resilience of Network Systems: a Fuzzy Sets Approach.

Le Val Lund, Whittier Narrows Earthquake, 1 October 1987: Water Lifeline Systems.

Le Val Lund, San Fernando Earthquake, 9 February 1971: Water Lifeline Lessons Learned.

John F. Meehan, School and Hospital Vulnerability and Rehabilitation

Michio Miyano and Toshio Mochizuki, On the Characteristics of Human Casualties due to Earthquake.

Toshio Mochizuki, Dangerous Factors in Living Environments to Human Casualties.

Hitomi O. Murakami, Yutaka Ohta and Hiroshi Kagami, A Diagnostic Assessment of Comprehensive Seismic Risk for the Household Unit.

Masaya Murakami, Tsuneo Okada, Yoshiaki Nakano and Hirohisa Yamaguchi, Seismic Capacity of Existing Medium- and Low-Rise Reinforced Concrete Buildings and Damage due to Past Earthquakes in Japan.

Masatake Nagano and Yasuyoshi Tatsumi, A Study on Disaster Prevention Planning in Big Cities: Some Problems of Earthquake Prevention Planning in the Littoral District Development Project.

Gianfranco Ottazzi, Shaking Table Test of Improved Adobe Masonry Houses.

Christopher Rojahn, Damage Estimation for Existing Buildings.

Tadanobu Sato and Kazuo Matsumura, Systematization of Data Bases Related to Natural Disaster Science.

Akenori Shibata, Assessment of Earthquake Hazard in Miyagi prefecture.

Hideaki Udagawa. Investigative Research Regarding the Estimation of Earthquake Damage in Tokyo.

Susumu Yamada, Countermeasures against Liquefaction for Urban Facilities.

Arthur J. Zeizel, Earthquake Loss- Estimation Methods.

PAPERS AT WORKING GROUP 4

Eileen V. Baumgardner, Hazardous Material Risk: Current Planning and Earthquake Hazard Reduction.

Frank T. Blackburn. Earthquake Preparedness in the City of San Francisco.

Frank W. Borden, Status of Earthquake Planning for Los Angeles Fire Department.

Eiichi Itoigawa and Isao Tsukagoshi, Stochastic Model for Fire Spread In Urban Area Based on Fire Brands Effect.

Shigeaki Kobayashi, Earthquake Damage to Hazardous Materials Facilities.

Yoshio Kumagai. A New Type Simulation for a Post-Earthquake Urban Fire Corresponding to any Winds Condition: A Winds-Puf.

Charles Scawthorn, Fire and Hazardous Materials Following Earthquake: U.S. Perspectives.

Tsutomu Takeda. Estimate of Fire Outbreak In Case of Earthquake.

Katheleen J. Tierney, Earthquake-Generated Hazardous Materials Releases: Research and Policy Issues.

Isao Tsukagoshi, Fire Protection for Wood- Flame Building and Fire Spread between Buildings.

PAPERS AT THE WORKING GROUP 5

Juliet T. Carrara, Potentjal Hazards Faced by Colleges. Universities and Research Centers and the Dangers They Pose for Surrounding Areas.

Terence P. Haney. California Earthquake Response Planning.

Takashi lwata and Ryutaro Osawa, Seismic Risk Mitigation System for City Gas Pipeline Network.

Nobumasa Kawabata. The Media in the Era of Earthquake Prediction: It's Role and Task.

Frederick Krimgold. Issues of Emergency Response to Urban Earthquake Disasters.

Yoshiteru Murozaki, Voluntary Activity in Emergency Response and Recovery.

Yoshiteru Nojima, Takashi Kawanaka and Toshikatsu lwami, A Basic Study of the Comprehensive Information System for Urban Disaster Management (CISUDIM).

Henrry R. Renteria, Governmental Response to the Earthquake Problem.

Ai Sekizawa, K. Sagae and H. Sasaki, A Systemic Approach for the Optimum Fire Fighting Capability against Multiple Fires Foilowing a Big Earthquake.

Guna Selvaduray, Hazardous Materials Issues In Earthquake Emergency Response.

Akira Toguchi, Lessons from lzu Oshima Volcanic Eruption Disaster.

Isao Tsukagoshi, Takashi Kawanaka. Eiichi Itoigawa, Hideki Kaji, Yoshio Kumagai and Toshikatsu lwami, Real Time Information System for Seismic City Fire.

Makoto Usami and Katsuo Tsuchiya, The Lessons of the 1987 East Off-Chiba Prefecture Earthquake.

PAPERS AT THE WORKING GROUP 6

Anand S. Arya. Repair and Strengthening of Earthquake Damaged Buildings, a Component of Long-Term Recovery Programme.

Patricia A. Bolton, Social Factors In Housing Recovery In Urban Earthquakes.

Kazuhiko Kawashima and Toshio lwasaki, Post Earthquake Repair Methods of Highway Bridges in Japan.

Kazuhiko Kawashima and Shigeki Unjo, Evaluation of Seismic Vulnerability of Highway Bridges in Japan.

Itsuki Nakabayashi. Recovery of Livelihood Following Recent Earthquake and Fire in Japan.

Kenneth C. Topping and Glenn O. Johnson, Pre-Event Planning for Earthquake Reconstruction: An Umbrella for the Future of Our Cities.

Susan K. Tubbesing, Social. Psychological, and Public Policy Issues during Post-Earthquake Recovery and Reconstruction.

Anselm J. Smolka and Gerhard Berz , Earthquake Insurance Data Requirements for Managing the Catastrophe Risk.

Shunsuke Sugano, Hiroaki Eto, Toshiyuki Noji and Kazuo Tamura, Seismic Capacity and Response of a Reinforced Concrete School Building in Mexico City which Suffered the Earthquake of 1985.

Loring A. Wyllie, Jr., Repair and Strengthening Building for Good Performance in the Next Earthquake.

4-3 LIST OF PARTICIPANTS

BRAZIL

Abrahao S. Ribeiro — Civil Engineer
Superintendency of Development of Northeast
Brazil, Interior Ministry, BRAZIL
(Currently studying in Japan)

CHINA

Lu Lin , — Graduate Student
Institute of Industrial Science
University of Tokyo
7-22-1 Roppongi, Minato-ku, Tokyo 106

ECUADOR

Carlos Villacis — Graduate Student
Institute of Industrial Science
University of Tokyo
7-22-1 Roppongi, Minato-ku, Tokyo 106

EGYFT

Gharib M. Hamada* — Professor
Egyptian Society for Earthquake Engineering
Department of Petrol, Faculty of Engineering
Cairo University
Giza, EGYPT

FEDERAL REPUBLIC OF GERMANY

Anselm J. Smolka — Munich Reinsurance Company
Koeniginstr. 107, D-8000 Munich 40
FEDERAL REPUBLIC OF GERMANY

INDIA

Anand S. Arya* — Professor
Department of Earthquake Engineering
University of Roorkee
Roorkee 247667, INDIA

Rajiv Duggal — Graduate Student
Institute of Industrial Science
University of Tokyo
7-22-1 Roppongi, Minato-ku, Tokyo 106

Satyendra P. Gupta* — Professor
Asian Disaster Preparedness Center
Asian Institute of Technology
P.O. Box 2754, Bangkok 10501, THAILAND

INDONESIA

Dradjat Hoedajanto* — Lecturer
Civil Engineering Department
Bandung Institute of Technology
Jalan Tubagus Ismail I/20
Bandung 40132, INDONESIA

IRAN

Aliakbar Moinfar — Consultant Engineer
Noavar Apt. D2, 6th St.
Farnaz St. Mohseni Sq., Mirdamad Ave.
Tehran 15478, IRAN

MEXICO

Felipe Lara-Rosano* — Professor
Institute of Engineering, UNAM
Apartado 70-418 Coyoacan
04510 Mexico D.F., MEXICO

PERU

Gianfranco Ottazzi* — Associate Professor
Department of Engineering
Catholic University of Peru
P.O. Box 1761, Lima, PERU

PHILIPPINES

Raymundo S. Punongbayan* — Director
Philippine Institute of Volcanology and Seismology
6th Floor, Hizon Bldg.
29 Quezon Avenue,
Quezon City, PHILIPPINES

YUGOSLAVIA

Vladimir Mihailov* — Professor
Institute of Earthquake Engineering and Engineering Seismology
University "Kiril and Metodij"
P.O. Box 101, 91000 Skopje, YUGOSLAVIA

U. S.A.

Ahmet Emin Aktan — Associate Professor
CEE Department, University of Cincinnati
ML 71 Cincinnati, OH 45221

Haluk M. Aktan — Associate Professor
Civil Engineering Department
Wayne State University
Detroit, MI 48202

Thalia Anagnos	Associate Professor Department of Civil Engineering San Jose State University San Jose, CA 95192
Christopher Arnold	President Building Systems Development, Inc. 3130 La Selva-Ste. 308,
San Mateo, CA 94403	
Eileen Baumgardner	Assistant Director Office of Emergency Services State of Caifornia 2800 Meadowview Rd Sacramento, CA 95832
Vitelmo Victorio Bertero	Professor of Civil Engineering University of California at Berkeley 783 Davis Hall, Berkeley, CA94720
Frank T. Blackburn	Head, Earthquake Preparedness, San Francisco Fire Department 1152 Oak St., San Francisco, CA 94117
Patricia Ann Bolton	Research Scientist Battele Seattle Research Center 4000 N.E. 41st St., Seattle, WA 98101
Roger D. Borcherdt	Research-Engineering Seismologist US Geological Survey 345 Middlefield Rd., Menlo Park, CA 94025
Frank Walter Borden	Fire Assistant Chief City of Los Angeles Fire Department 534 E. Edgeware Rd., Los Angeles, CA 90026
Juliet Therese Carrara	Emergency Preparedness Coordinator Environmental Health and Safety 2223 Fulton St., Univ. of California Berkeley, CA 94720
Mehmet K. Celebi	Research Civil Engineer U.S. Geological Survey 345 Middlefield Rd. (MS977) Menlo Park, CA 94025
Oris H. Degenkolb	(Retired) 1910 Picasso Ave., Davis, CA 95616
Richard K. Eisner	Director BAREPP/OES, State of California Metrocenter 101 8th St., Suite 152 Oakland, CA 94607
Paul J. Flores	Project Director, So. California Earthquake Preparedness Profect 600 So, Commonwealth Ave., Suite 1000 Los Angeles, CA 9000

Edward S. Fratto	Assistant Director NSEPP, Commonwealth of Massachusetts 400 Worcester Road, P.O. Box 1496 Framingham, MA 01701
Terence P. Haney	President, Terence Haney Co. 5943 Salamea Ave., Woodland Hills, CA 91367
Glemn Otto Johnson	Principal City Planner Los Angeles City Planning Department 200 North Spring St., R 500, City Hall, Los Angeles, CA 90012
Harry Kim*	Civil Defense Administration for County of Hawaii Hawaii County Civil Defense Agency 34 A Rainbow Drive Hilo, Hawaii 96720
Frederick Krimgold	Associate Dean Virginia Polytech Inst. & State Univ. Washington-Alexandria Center, 101 N. Columbus St., Alexandria, VA 22314
Randoloph Langenbach	Associate Professor Department of Architecture University of California at Berkeley 232 Wurster Hall, Dept. of Architecture Berkeley, CA 94720
Bob Lanning	Hewlett-Packard Mail Stop 20 CE, 300 Hanove St., Palo Alto, CA 94304
Le Val Lund Water	Los Angeles Department of Power and P.O. Box 111, Room 1466 Los Angeles, CA 90051
Shirley Mattingly	Director of Emergency Management City of Los Angles 200 N. Main St. Room 300 Los Angeles, CA 90012
John Francis Meehan	(Self-employed) 671 Laurel Dr., Sacramento, CA 95864
Robert Alan Olson	President, VSP Associates Inc. 455 University Ave. #340 Sacramento, CA 95825
Jane Preuss	Owner, Urban Regional Research 1809 7th Ave., Suite 1000, Seattle, WA 98101
Henry R. Renteria	Emergency Service Manager City of Oakland City Manager's office, One City Hall Plaza Oakland, CA 94612

Christopher Rojahn	Executive Director Applied Technology Council 3 Twin Dolphin Dr., Suite 275 Redwood City, CA 94065
Richard J. Roth, Jr.	Assistant Commissioner Department of Insurance 600 So, Commonwealth Ave. Los Angeles, CA 90005
Charles Scawthorn	Vice President EQE Inc. 495 Market St. 18th Floor San Francisco, CA 94105
Guna Selvaduray	Professor Department of Materials Engineering San Jose State University San Jose, CA 95192
Paul G. Somerville	Senior Project Seismologist Woodward-Clyde Consultants 566 El Dorado St., Pasadena, CA 91101
Katheleen J. Tierney	Adjunct Associate Professor University of Southern California ISSM #108, University Park Los Angeles, CA 90089-0021
Thomas L. Tobin	Executive Director California Seismic Safety Committee 1900 K St, Suite 100, Sacramento, CA 95814
Susan K. Tubbesing	Executive Director Earthquake Engineering Research Inst. 6431 Fairmount, Suite 7 El Cerrito, CA 94530
Loring A. Wyllie, Jr.	Chairman H. J. Degenkolb Association 350 Sansome St., #900 San Francisco, CA 94104
Arthur J. Zeizel	Policy Manager Federal Emergency Management Agency 500 C. St. SW Washington D.C. 20472, JAPAN
Osamu Arai	Director Earthquake Disaster Countermeasure Div. National Land Agency 1-2-2 Kasumigaseki, Chiyoda-ku, Tokyo 100

Fumio Daimon	Section Manager Fire and Marine Insurance Rating Association 2-9 Kanda Awaji-cho, Chiyoda-ku, Tokyo 101
Kimio Goto	Fire Bureau, City of Yokohama 2-9 Kawabe-cho, Hodogaya-ku, Yokohama 240
Masanori Hamada	Professor School of Marine Science and Technology Tokai University 3-21-1 Orido, Shimizu, Shizuoka 424
Masanao Haraguchi	Section Chief for Disaster Countermeasures Disaster Prevention Division Department of Environment Saitama Prefectural Government 3-15-1 Takasago, Urawa, Saitama 336
Haruo Hayashi	Associate Professor Department of Social Psychology Hirosaki University Bunkyo-cho, Hirosaki, Aomori 036
Norimasa Hayashi	Assistant Counsellor Disaster Prevention and Fire Division Environmental Department Kanagawa Prefectural Government Nihon-Ohdori, Naka-ku, Yokohama 231
Kunihiko Hirai	Secretary-General Urban Safety Research Institute Iino Bldg. 215 2-1-1 Uchisaiwai-cho, Chiyoda-ku, Tokyo 100
Yasushi Hirano	General Officer Shimizu Fire Department 6-8 Asahi-cho, Shimizu, Shizuoka 424
Kinya Hirata	Chief Office of Disaster Preparedness City of Yokohama Minatomachi, Naka-ku, Yokohama 231
Akihiko Hokugo	Fire Information Research Center 3-14-12 Nakahara, Mitaka, Tokyo 181
Ikuo Hori	Technical Counsellor Industrial Safety Division Department of Environment Kanagawa Prefectural Government Nihon-Odori, Naka-ku, Yokohama 231
Masaru Hoshiya	Professor Musashi Institute of Technology 1-28 Tamazutsumi, Setagaya-ku, Tokyo 158

Hirokazu Iemura
Associate Professor
Department of Civil Engineering
Kyoto University
Yoshida Honmachi, Sankyo-ku,
Kyoto 606

Morio Ino
Manager
Earthquake Preparedness Division
Shizuoka Prefectural Government
9-6 Otemachi, Shizuoka 420

Michio Ishibashi
Researcher, Civil Engineering Division
Engineering Research Center
Tokyo Electric Power Co., Inc.
2-4-1 Nishitsujigaoka, Chofu, Tokyo 182

Masuhiro Ishikawa
Specialist for Earthquake Disaster
Earthquake Disaster Prevention Div.
Fire Defense Agency
Ministry of Home Affairs
2-1-2 Kasumigaseki, Chiyoda-ku,
Tokyo 100

Ryoji Isoyama
Section Chief
Earthquake Disaster Mitigation
Japan Engineering Cousultants
2-2-6 Okubo, Shinjuku-ku, Tokyo 160

Shigeru Ito
Professor
Department of Urban Engineering
University of Tokyo
7-3-1 Hongo, Bunkyo-ku, Tokyo 113

Eiichi Itoigawa
Researcher
Building Research Institute
Ministry of Construction
1 Tatehara, Tsukuba, Ibaragi 305

Toshikatsu Iwami
Associate Professor
University of Tsukuba
Tennodai, Tsukuba, Ibaragi 305

Takashi Iwata
Planning Section
Pipeline Planning and
Administration Dept.
Tokyo Gas CO., Ltd.
1-5-20 Kaigan, Minato-ku, Tokyo 105

Takayoshi Iwata
Earthquake Preparedness Division
Shizuoka Prefectural Government
9-6 Otemachi, Shizuoka 420

Jun Izumi*
Research Associate
UN Centre for Regional Development
1-47-1 Nagono, Nakamura-ku, Nagoya
450

Hideki Kaji*	Professor Institute of Socioeconomic Planning University of Tsukuba 1-1 Tennodai, Tsukuba, Ibaragi 305
Hiroyuki Kameda	Professor-in-Charge Urban Earthquake Hazard Research Center Kyoto University Gokasyo, Uji, Kyoto 611
Kihei Kmigane	Planning Officer Disaster Prevention Bureau National Land Agency 1-2-2 Kasumigaseki, Chiyoda-ku, Tokyo 100
Noritaka Katatani	Chief of Development Section V Technology Development Department Fujitsu Facom Information Processing Corporation 4-14 Kamiyama-cho, Shibuya-ku, Tokyo 150
Tsuneo Katayama	Professor Institute of Industrial Science University of Tokyo 7-22-1 Roppongi, Minato-ku, Tokyo 106
Nobumasa Kawabata	Deputy General Manager News Division Shizuoka Broadcasting Systems 3-1-1 Toro, Shizuoka 422
Masaaki Kawaguchi	Fire and Marine Insurance Rating Association 2-9 Kanda Awaji-cho, Chiyoda-ku, Tokyo 101
Takashi Kawanaka	Researcher Urban Disaster Prevention Division Building Research Institute Ministry of Construction 1 Tatehara, Tsukuba, Ibaragi 305
Kazuhiko Kawashima	Head of Earthquake Engineering Div. Earthquake Disaster Prevention Department Public Works Research Institute Ministry of Construction 1 Asahi, Tsukuba, Ibaragi 305
Kanji Kimura	Deputy General manager and manager for Fire Underwriting Division of Fire and Casualty Coordinating Department Yasuda Fire and Marine Insurance Co., Ltd. 1-26-1 Nishi-shinjuku, Shinjuku-ku, Tokyo 160

Michihiro Kitahara
Associate Professor
School of Marine Science
and Technology
Tokai University
3-20-1 Orido, Shimizu, Shizuoka 424

Masami Kobayashi
Lecturer
Department of Architecture
Faculty of Engineering,
Kyoto University
Yoshida Honmachi, Sakyo-ku, Kyoto 606

Shigeaki Kobayashi
Chief of Hazardous Materials Section
Tokyo Fire Department
1-3-6 Otemachi, Chiyoda-ku, Tokyo 100

Osamu Koide
Associate Professor
Division of Urban Environment System
Research Center for Advanced Science
and Technology
4-6-1 Komaba, Meguro-ku, Tokyo 153

Keizaburo Kubo
Emeritus Professor of
University of Tokyo
Director
Association for the Development of
Earthquake
Prediction
3 Kanda Mitoshiro-cho, Chiyoda-ku,
Tokyo 101

Tetsuo Kubo
Associate Professor
Department of Architecture
Nogoya Institute of Technology
Gokisomachi Showa-ku, Nagoya 466

Yoshio Kumagai
Associate Professor
Institute of Socioeconomic Planning
University of Tsukuba
1 Tennodai, Tsukuba, Ibaragi 305

Katsuhiko Kuroda
Associate Professor
Department of Transportation
Engineering
Faculty of Engineering,
Kyoto University
Yoshida Honmachi, Sakyo-ku, Kyoto 606

Shigeo Kurozu
C/O Urban Safety Research Institute
Iino Bldg. 215
2-1-1 Uchisaiwai-cho, Chiyoda-ku,
Tokyo 100

Fumimasa Kuzuno
Technical Senior Counsellor
Disaster Prevention and Fire Division
Environment Department
Kanagawa Prefectural Government
1 Nihon-Odori, Naka-ku, Yokohama 231

Iware Matsuda
Associate Professor
Department of Geology
Tokyo Metropolitan University
2-1-1 Fukazawa, Setagaya-ku,
Tokyo 158

Fusanori Miura
Associate Professor
Department of Civil Engineering
Faculty of Engineering, Yamaguchi University
Tokiwadai, Ube, Yamaguchi 755

Michio Miyano
Lecturer
Department of Housing and Design
Osaka City University
3-3-138 Sugimoto, Sumiyoshi-ku, Osaka 558

Tohru Miyazawa
Manager of Civil Protection Group
Yaizu Plant, Yamanouchi Pharmaceutical Co.
180 Ohzumi, Yaizu, Shizuoka 425

Toshio Mochizuki
Professor
Center for Urban Studies
Tokyo Metropolitan University
Yaakumo, Meguro-ku, Tokyo 152

Shuji Mukunoki
Assistant Division Chief
Earthquake Disaster Countermeasure Division
Disaster Prevention Bureau
National Land Agency
1-2-2 Kasumigaseki, Chiyoda-ku, Tokyo 100

Hitomi O. Murakami
Research Associate
Department of Architectural Engineering
Hokkaido University
North 13 West 8, Sapporo 060

Ken'ichi Murakami
Tokyo Fire Department
1-3-5 Otemachi, Chiyoda-ku, Tokyo 100
(Currently, at University of Tsukuba)

Masaya Murakami
Professor
Department of Architectural Engineering
Chiba University
1-33 Yayoi-cho, Chiba 260

Suminao Murakami
Professor
Architecture and Environment Planning
Faculty of Engineering
Yokohama National Unviersity
156 Tokiwadai, Hodogaya-ku, Yokohama 240

Yoshiteru Murozaki
Professor
Architecture and Environmental Planning
Kobe University
Rokkodai, Nada-ku, Kobe 657

Masatake Nagano
Chief Research Engineer
Earthquake Engineering
Takenaka Technical Research Laboratory
2-5-14 Minamisuna, Koto-ku, Tokyo 136

Itsuki Nakabayashi
Associate Professor
Department of Geography
Tokyo Metropolitan University
2-1-1 Fukazawa, Setagaya-ku,
Tokyo 158

Hisashi Nirei
Director
Research Institute of Environmental Geology
Chiba Prefectural laboratory of Water Pollution
3-5-1 Inagekaigan, Chiba 281

Nobuoto Nojima
Graduate Student
Kyoto University
Gokasyo, Uji, Kyoto 611

Yoshiteru Nojima
Head of Urban Disaster Prevention Div。
Building Research Institute
Ministry of Construction
1 Tatehara, Tsukuba, Ibaragi 305

Yujiro Ogawa
Research Director
Urban Safety Research Institute
Iino Bldg. 215
2-1-1 Uchisaiwai-cho, Chiyoda-ku,
Tokyo 100

Ichiro Ohkado
C/O Urban Safety Research Institute
Iino Bldg. 215
2-1-1 Uchisaiwai-cho, Chiyoda-ku,
Tokyo 100

Tatsuo Ohmachi
Professor
Graduate School at Nagatsuda
Tokyo Institute of Technology
4259 Nagatsuda, Midori-ku,
Yokohama 227

Kazuyoshi Ohnishi
Research Associate
Kobe University
Rokkodai, Nada-ku, Kobe 657

Keiji Okamoto
Director
Urban Disaster Prevention Section
City Bureau
Ministry of Construction
2-1-3 Kasumigaseki, Chiyoda-ku,
Tokyo 100

Yasuhide Okuyama
Architectural Engineer
Kumagai Gumi Co.,Ltd.
2-1 Tsukudo-cho, Shinjuku-ku,
Tokyo 162

Yoshihiko Ozawa
Chief of Staff
Earthquake Preparedness Division
Shizuoka Prefectural Government
9-6 Otemachi, Shizuoka 420

Takashi Saito — Director
Office of Disaster Preparedness
City of Yokohama
Minatomachi, Naka-ku, Yokohama 231

Tadanobu Sato — Associate Professor
Disaster Prevention Research Institute
Kyoto University
Gokasho, Uji, Kyoto 611

Hidehiko Sazanami* — Director
UN Center for Regional Development
1-47-1 Nagono, Nakamura-ku,
Nagoya 450

Aki Sekizawa — Earthquake Disaster Section
Fire Research Institute
Ministry of Home Affairs
3-14-1 Nakahara, Mitaka, Tokyo 181

Akenori Shibata — Professor
Faculty of Engineering
Tohoku University
Aoba, Aramaki, Sendai 980

Kishie Shigekawa — Research in Chief
Urban Safety Research Institute
Iino Bldg. 215
2-1-1 Uchisaiwai-cho, Chiyoda-ku,
Tokyo 100

Yasuo Shioji — Safety and Environmental Pollution Control
Manager, Kawasaki Operation Center
Nippon Petrochemicals Co.
2-3-1 Yako, Kawasaki-ku, Kawasaki 210

Shunsuke Sugano — Chief Research Engineer
Takenaka Technical Research Laboratory
2-5-14 Minamisuna, Koto-ku, Tokyo 136

Tadashi Sugi — Manager of Civil Engineering Division
Engineering Research Center
Tokyo Electric Power Co.
2-4-1 Nishitsutsujigaoka, Chofu, Tokyo 182

Takashi Sugiyama — Disaster Prevention Section
Bureau of Civil Engineering
Kawasaki City Office
1 Miyamoto-cho, Kawasaki-ku,
Kawasaki 210

Toshiro Sugiyama — Head of Disaster Prevention Bureau
Shizuoka Prefectural Government
9-6 Otemachi, Shizuoka 420

Hideyo Suzuki — Researcher of Civil Engineering Division
Engineering Research Center
Tokyo Electric Power Co.
2-4-1 Nishitsutsujigaoka, Chofu,
Tokyo 182

Kohei Suzuki	Professor Mechanical Engineering Tokyo Metropolitan University 2-1-1 Fukazawa, Setagaya-ku, Tokyo 158
Masatoshi Suzuki	Senior Civil Engineer Nikken Sekkei Ltd. 2-11-11 Koraku, Bunkyo-ku, Tokyo 112
Hiromi Tadasue	Research Associate Division of Urban Developmental System Research Center for Advanced Science And Technology 4-6-1 Komaba, Meguro-ku, Tokyo 153
Kazuo Tajima	Manager Disaster Prevention Division Bureau of Civil Engineering Kawasaki City Office 1 Miyamoto-cho, Kawasaki-ku Kawasaki 210
Norio Takahashi	Manager of Planning Section Fire Bureau, City of Yokohama 2-9 Kawabe-cho, Hodogaya-ku, Yokohama 240
Tetsuo Takamoto	
Tsutomu Takeda	Senior Office Disaster Div., Tokyo Fire Department 1-3-5 Otemachi, Chiyoda-ku, Tokyo 100
Yoshihiro Takeuchi	Professor Department of Architecture Faculty of Engineering Osaka Institute of Technology 5-16-1 Ohmiya, Asahi-ku, Osaka 535
Masahiro Tanaka	Civil Engineering of Administration Div. Hydro-Generation and Transmission Engineering Department Tokyo Electric Power Co., Inc. 1-1-3 Uchisaiwai-cho, Chiyoda-ku, Tokyo 100
Yasunaga Tatsumi	Research Engineer Takenaka Technical Research Laboratory 2-5-14 Minamisuna, Koto-ku, Tokyo 136
Akira Toguchi	Section Chief of Disaster Countermeasures Emergency Service Section Disaster Prevention Division Bureau of General Affairs Tokyo Metropolitan Government 3-5-1 Marunouchi, Chiyoda-ku, Tokyo 100

Kensaku Tokuda	Chairman Committee of Promotion of Self-Disaster-Prevention's Activities in Shizuoka Prefecture
Tadashi Tomita	Section Chief for Earthquake Countermeasure Disaster Prevention Division Department of Environment Saitama Prefectural Government 3-15-1 Takasago, Urawa, Saitama 336
Katsuo Tsuchiya	Fire and Disaster Prevention Division General Affairs Department Chiba Prefectural Government Ichiba-cho, Chiba 280
Isao Tsukagoshi	Associate Director for Fire Research Building Research Institute Ministry of Construction 1 Tatehara, Tsukuba, Ibaragi 305
Hideaki Udagawa	Deputy Section Chief, Planning Section Disaster Prevention Division Bureau of General Affairs Tokyo Metropolitan Government 3-5-1 Maunouchi, Chiyoda-ku, Tokyo 100
Shigeki Unjo	Research Engineer Public Works Institute Ministry of Construction 1 Asahi, Tsukuba, Ibaragi 305
Makoto Usami	Chief, Fire and Disaster Prevention Div. General Affairs Department Chiba Prefectural Government Ichiba-cho, Chiba 280
Yutaka Yamamoto	Tokyo Fire Department 1-3-5 Otemachi, Chiyoda-ku, Tokyo 100 (Currently at University of Tsukuba)
Susumu Yasuda	Professor Department of Civil Engineering Kyusyu Institute of Technology Sensui-cho, Tobata-ku, Kitakyushu 804
Shigeru Yokouchi	Director Chubu Electric Company
Hiroaki Yoshii	Professor Bunkyo University 1100 Yukigawa, Chigasaki 253
Shin'ichi Yoshimura	Fire Bureau, City of Yokohama 2-9 Kawabe-cho, Hodogaya-ku, Yokohama 240

Minoru Watanabe

Researcher in Chief
Urban Safety Research Institute
2-1-1 Uchisaiwai-cho, Chiyoda-ku,
Tokyo 100

NOTE

* Participants who attended the Nagoya Meeting.