

## ABSTRACTS

Abstracts of the papers from the registered participants are presented in this chapter. They are arranged in alphabetical order by authors' surnames in the following groups:

- A. Earthquake hazard
- B. Flood hazard
- C. Ground-failure hazard
- D. Volcano hazard
- E. Extreme-wind hazard

The papers that were received in time for publication are contained in the *Proceedings of the Second U.S.-Asia Conference on Engineering for Mitigating Natural Hazards Damage (EMNHD-2) 22-26 June 1992, Yogyakarta, Indonesia*. A limited number of single copies are available from Prof. Arthur N.L. Chiu, Department of Civil Engineering, University of Hawaii at Manoa, Honolulu, Hawaii 96822, U.S.A.

## **A. EARTHQUAKE HAZARD**

### **DAMAGE ASSESSMENT OF EXISTING BRIDGE STRUCTURES WITH SYSTEM IDENTIFICATION**

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A method for estimating the damage of existing bridge structures is developed using results of system identification. For damage assessment, structural properties must include the nonlinear parameters, which may be evaluated through system identification. Dynamic behavior of damaged structures is represented by a nonlinear hysteretic moment model. To incorporate the variability of the structural properties and the effects of stochastic excitations, response statistics are obtained through random vibration and damage is represented as random quantities. A numerical example is illustrated for a bridge structure subjected to earthquake excitations.

### **GIS-A CONVENIENT TOOL FOR NATURAL HAZARD STUDIES AND ANALYSIS**

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GIS systems and data formatted for use in such systems are becoming readily available at a relatively modest cost due to the wide applicability of these systems. This provides a new tool and opportunity for application of this tool as a part of a macro engineering approach for natural hazard problems. A brief description of some of the features of GIS systems and data available are provided. Two examples, one in a planning stage and the other almost developed to an operational level are described. The first example concerns the opportunities for display and manipulation of wind data and the other example concerns a GIS-based regional risk approach for bridges subjected to earthquakes.

### **SEISMICITY AND ITS RELATION TO THE VOLCANIC'S ACTIVITY IN INDONESIA**

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The seismicity in Indonesia related with the Benioff zones which subduct in different directions with heterogent dip angles. Many trenches found in this region indicated subduction zones. The tectonics structure in the eastern Indonesia more complex than in the western Indonesia.

The Indonesian region is an active seismic area, it is recorded that on the average about 460 earthquakes per year with the magnitude equal and greater than 4 in Richter scale.

The subduction zones of 180 km depth are founded from Sumatra to West Java, and begin of Central Java to Flores reaching 665 km depth. In the Banda Sea region, the subduction zones are face to face and have a convex form with decreasing depth from west to east: from 650 to 96 km. In the other case, around Molucca area the tectonic plates descend to the west reaching 658 km depth, and to the east into the depth of about 275 km forming a concave. The aseismic zones of 80 - 282 km width can be found between Central Java and Flores, and about 223 km width the south of Mindanao.

In the simple subduction of Sumatra, the distribution of volcanoes correspond to the end of the subduction plate. In Java, up to Banda Sea area, the volcanoes have not direct relation to discontinued zone. In South Molucca the activity of volcanoes correspond to the end of subduction zone, but in Central Molucca it is found that the volcanoes are above the active seismic area.

## **ATTENUATIONS OF SEISMIC WAVES**

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Far-field displacement components in vibration problems of multilayered isotropic elastic and viscoelastic half spaces, taken as the idealized models of the earth media, are presented in closed forms for three simple fundamental problems: a homogeneous half space, a homogeneous full space, and two different half spaces perfectly bonded together. Results for transient waves are also presented.

## **TECHNOLOGY TRANSFER IN EARTHQUAKE ENGINEERING RESEARCH\***

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There is a widespread view in the United States that a major impediment to earthquake hazard reduction is not the lack of new knowledge but rather the delayed application of available knowledge. Technology transfer is therefore being given greater emphasis by those federal and state agencies responsible for mitigating the earthquake hazard.

The National Center for Earthquake Engineering Research was established by the National Science Foundation in 1986 for the express purpose of conducting systematic research in earthquake engineering and to improve the rate of transfer of research results in practice. Accordingly, the Center is actively engaged in technology transfer by a variety of means. These activities may be grouped under "traditional" and "special initiative" headings.

Traditional technology transfer mechanisms include: (a) publication of technical reports, (b) conduct of conferences, workshops and seminars, (c) conduct of short courses for the professions and (d) development of design aids and user-friendly computer software.

However, traditional methods are passive by nature and need to be supplemented by special initiatives. Pro-active strategies, which the Center has found to be successful, include methods that improve the usefulness of the research product and provide improved access to research results and related information.

Techniques for improving the usefulness and quality of research include using multidisciplinary research teams, placing end-users on research teams and sponsoring demonstration projects. Improved access is provided through a new Information Service, the development of expert systems and the placement of qualified researchers on code committees.

This paper summarizes these activities and illustrates their potential benefits by describing a case study in the seismic vulnerability of a water delivery system.

\* Theme Paper

### **THE USE OF NATURAL RUBBER BEARINGS TO PROTECT A SMALL APARTMENT BLOCK FROM EARTHQUAKE DAMAGE**

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Seismic isolation is a novel technique of earthquake protection which involves mounting the building or structure on laminated rubber-steel bearings. The horizontal stiffness of the bearings is designed to give the mounted structure a horizontal natural frequency of about 0.5 Hz. This is below the frequency range in which most of the energy of earthquakes for rock and stiff soil sites is typically concentrated. The building is thus detuned from the ground motion occurring during an earthquake, and the accelerations it experiences are much reduced. Furthermore, the mounted structure will behave predominantly as a rigid body with little amplification of the base acceleration at other levels. Seismic isolation is superior to conventional methods of strengthening because not only is damage to the primary structure minimised, but secondary structural features, building contents and occupants are protected.

The technical and economic feasibility of applying seismic isolation to a small building in a country such as Indonesia is currently being assessed by means of a project involving the construction of a small four-storey building on a site near Pelabuhan Ratu in S.W. Java. The area has a reasonable degree of seismic activity thus providing the possibility of a direct assessment of the technical performance of the building. The paper gives details of the building and outlines the principles of seismic isolation and how the design of the isolation system is approached. As well as technical aspects, economic factors and appropriateness of this technology for countries such as Indonesia are discussed.

## **ANALYSIS AND DESIGN OF A BASE-ISOLATED BUILDING**

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This paper presents the preliminary analysis and design of the first base-isolated building located in Shantou City, China. Based on the column load distribution, circular isolation bearings of 600-mm diameter and 190-mm thickness are proposed. The bearings are designed for a 120-mm design displacement and a 240-mm maximum displacement. Supported on 23 bearings, the isolated building has a 0.5 Hz natural frequency. Subjected to the site-specific spectrum of 0.2g peak ground acceleration, the maximum acceleration response is 0.16g for the isolated building compared with 0.43g for the fixed-base building. The maximum displacement response at the base level of the isolated building is 105 mm.

## **ZONING METHOD: ONE OF TECHNOLOGY TO LIVE WITH GEOLOGIC HAZARD AREA**

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Tectonically, Indonesia is situated in the active area. It is called an island arc, as indicated by an arcuate shape of the island chains, trenches, active volcanoes and earthquake activity and the chain of islands. On the other hand some part of the eastern Indonesia region is more complicated. Consequently, the area will be vulnerable to some hazard such as earthquake, volcanoes and landslide. The third one is also caused by thick soil due to strong weathering processes, and heavy rain in the tropical region.

Zoning is technology which divide an area in some region according to the hazard level. Earthquake zoning map will divide the area based on possible damage or ground motion criteria. volcanic zoning map will divide the region based on the hazard level due to volcanic products from the crater of volcano. Landslide zoning map will delineate the area according to possible landslide hazard. Indonesia is the fourth country in the numbers of population in the world. Because of this, in some places people have to live in the geologic hazard area. Population condition force the people to live in these hazards areas. Therefore the zoning map should be used as much as possible in any landuse planning of the area. Even in the danger area, if there is some advantage the region could still be utilized with the same boundary condition.

## **RISK MANAGEMENT FOR NATURAL DISASTERS: A GLOBAL PERSPECTIVE**

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Almost 85 percent of all deaths due to natural disasters occur in Asia and the Pacific Rim. As the urbanization of major cities and communities increase at a spectacular rate, the risk to lives and property continues to increase. It is no wonder that in spite of major technological and scientific innovations, the level of risk in many parts of the world is not decreasing.

Planners, scientists, and engineers have studied various natural hazards and their mitigation strategies. However, there is relatively very little work done on an integrated approach to risk management. As an example, earthquakes cause many types of losses. They can be categorized as follows:

- \* Life and injury;
- \* Property damage;
- \* Business interruption;
- \* Lost opportunities;
- \* Building contents and damage;
- \* Long-term social, economical and political implications;
- \* Other losses.

Even for this specific natural hazard, very limited effort is spent in developing a balanced resource allocation strategy to maximize benefits and minimize the above mentioned losses.

Two important segments of the risk management groups that have not been involved in research or implementation are the financial and the insurance industries. Even though these two sectors deal with the enormous consequences of natural disasters, their expertise, their needs and their input have not been integrated with other professional and scientific sectors. In short, the scientific and technological communities (knowledge generators) do not communicate with the financial-banking and insurance-communities (knowledge users). The result is that less than optimum strategies are used to manage risk.

This paper will review the current state-of-art in earthquake risk management. It will then provide elements of integrated risk management strategies to mitigate the effects of earthquake hazard. The suggested strategies and how they should be implemented in developing and developed nations will be discussed. The goals of IDNDR and means for achieving these goals will be presented.

## **DISASTER ESTIMATION CAUSED BY FAILURE OF CRITICAL FACILITIES DUE TO NATURAL HAZARD\***

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This paper will deal with the necessity of estimating a procedure of the secondary disaster caused by failure of critical facilities such as petrochemical engineering plants, oil storages, nuclear facilities and so on. The secondary disasters are caused by diffusion of poisonous gas, blasting and burning of flammable gas in urban area mainly. This paper will discuss how to generate the scenario of the secondary disaster and how to estimate the failure of such facilities under destructive earthquake conditions; that is, how to estimate the failure probability of equipment and piping systems in such facilities, and finally how to estimate the diffusion of poisonous and flammable gases to the populated area. Main part of the discussion will emphasize on how to estimate the failure probability of facilities distributed in an urban area.

\* Theme Paper

## **AN ASSESSMENT MODEL FOR EARTHQUAKE FATALITIES**

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By integrating existing knowledge in seismology, earthquake engineering, and injury epidemiology, we developed a computer model for the estimation of expected fatalities in any given earthquake. Our design purpose for this model was to provide adequate information applicable to the development of safety plans for the reduction of earthquake casualty. We used a very limited range of input variables in order to enhance the model's applicability. Required in the estimation were earthquake magnitude, epicentral position, and three regional data of population, building type, and ground condition. We tested the performance accuracy of the model using the data collected from 16 significant disasters between 1962 and 1986.

## **PROBABILISTIC SEISMIC HAZARD ESTIMATES IN NORTH SULAWESI PROVINCE, INDONESIA**

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Earthquake ground-motions in North Sulawesi on soft soil that have a 90 percent probability of not being exceeded in 50 years are estimated to be 0.46g (46 percent of the acceleration of gravity) at Palu, 0.31g at Gorontalo, and 0.27g at Manado. Estimated ground-motions for rock conditions for the same probability level and exposure time are 56 percent lower on average than the hazard estimated on soft soil. The hazard estimates are obtained from seismic sources that model the earthquake potential to a depth of 100 km beneath northern and central Sulawesi. Significant seismic sources include the Palu fault zone of western Sulawesi, the North Sulawesi subduction zone and the southernmost segment of the Sangihe subduction zone beneath the Molucca Sea. An attenuation relation derived from Japanese strong-motion data and considered appropriate for subduction environments of the western Pacific was used in the determination of expected ground-motions.



## **B. FLOOD HAZARD**

### **TO IMPROVE HEAVY RAINFALL FORECAST: TAIWAN AREA MESOSCALE EXPERIMENT (TAMEX)**

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TAMEX is a research program to improve, through better understanding, the forecasting of heavy precipitation events that lead to flash floods. The program was proposed to the National Science Council and meteorological community in Taiwan in 1983. After about 4 years planning, the field phase was carried out successfully in May - June 1987. A 5-year follow-up research plan to cover both the basic and applied researches started right after the field phase in 1988. The Post-TAMEX Forecast Exercise, to be carried out in May - June 1992, is planned to complete this 10-year TAMEX program. The objective of this Forecast Experiment is to apply the scientific results and forecast techniques generated by the TAMEX program and to develop nowcasting (0 - 3h) and very-short-range forecasting (3 - 24h) capabilities in the heavy rainfall forecast in the Mei-Yu season. An overview of this 10-year program is given in this paper.

### **PROCESSES OF RIVER BANK EROSION DURING FLOODS**

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Bank line retreat of a low water course caused by hydraulic scour and collapsing/slipping process has been observed since 1980 at a site in the Uji River, a middle reach of the Yodo River, in Kinki District, Japan. The bank erosion processes are discussed with a local bed scour at a toe of side slopes and its stability is evaluated by a simplified Junbu method of slope stability analyses. Local bed scour near the bank of the low water course causes bank slope instability and the slip failure is predicted to take place after overbank floods.

### **FLOODS EXPECTED DUE TO GLOBAL WARMING**

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Global warming will affect future floods; therefore, careful consideration of all parameters involved is necessary. Changes in temperature, precipitation and solar radiation are given by three global circulation models (GFDL, GISS and UKMO) assuming a scenario of doubling of carbon dioxide (CO<sub>2</sub>). The effects of these changes on runoff can be predicted using a rainfall-runoff model like the Sacramento Model which considers all these parameters. Calibrating these models presents large difficulties so that the results can only be considered as preliminary.

Some results show increase in floods of a certain annuity due to increased precipitation. In other cases the increased temperature, solar radiation and potential evapotranspiration decrease runoff and soil moisture. Definite conclusions as to whether floods are increased or decreased by global warming cannot be drawn at this stage.

A small catchment (Maetaeng River) in northern Thailand served as a case study. This tropical catchment (1765 km<sup>2</sup>) is in a natural condition, without human influence. The maximum flow is about 700 m<sup>3</sup>/s in rainy season; average flow is around 22 m<sup>3</sup>/s. The mean annual precipitation is 1350 mm.

Future studies should try to predict more accurately the meteorological changes and the dates when they will occur. Further, improved rainfall-runoff modeling should yield more reliable prediction of floods.

## **FLOOD HAZARDS MITIGATION IN MALAYSIA**

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Flooding is a significant natural hazard in Malaysia. Some 29,000 sq km or nine percent of the total land area of Malaysia is flood prone affecting about 2.7 million people. The average annual flood damage is estimated at M\$100 million. After the disastrous flood of 1971, the Government has taken positive steps to deal with the flooding problems. The strategies adopted comprise institutional development, implementation of structural and nonstructural measures and a pro-active approach of comprehensive catchment planning and management. The Government's commitment is reflected in the increasing public expenditures on flood mitigation works. All these measures are aimed at creating a favorable environment to support and promote socio-economic development in the country.

## **INTEGRATION OF NONSTRUCTURAL MEASURES INTO FLOOD CONTROL PLANNING**

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The nonstructural approach to flood control was introduced in the United States to supplement costly dams, levees, and channels to control floods. When flood damages were still increasing despite an extensive structural program, the use of nonstructural measures was seen as a way to cut costs and reduce the environmental disruption of constructing large facilities. However, nonstructural methods shift much of the cost burden to the private sector by making land less productive and construction more expensive. The structural/nonstructural balance is particularly important in developing countries because both large flood losses and large development costs can retard economic growth.

The middle way is to combine measures in programs that help people improve their lives despite flooding. Each floodplain is unique, and each situation requires a separate analysis to choose the best measures and provide for their effective implementation and efficient operation. This paper discusses the measures, their

assessment, and their combination. Of the nonstructural measures, flood proofing helps where the floods are shallow; land management is more appropriate with deeper flooding; and contingency programs provide backup during major disasters.

## **EFFECTS OF THE WAR ON FLOOD DAMAGES IN HIROSHIMA DUE TO TYPHOON 4516**

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Just after the Second World War, typhoon 4516, which landed on Makurazaki, Kyusyu Island on 17 September 1945 with the atmospheric pressure of 916.4mb, generated severe damage in Hiroshima. The nationwide loss of lives due to the typhoon was 3128, and two-thirds of the dead were counted in Hiroshima. The factors that enlarged the damage in Hiroshima are (1) lack of proper meteorological observation systems, (2) delay of debris and flood control works and (3) A-bombed wide area. They were all influenced by the war which reduced disaster prevention potential. Due to the war, the government cut down the budget of land development and the draft of civil engineers affected the continuity of the public works programs.

## **FLOOD ACTION PLAN OF BANGLADESH: A CRITICAL REVIEW\***

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Flood is a recurring phenomenon in Bangladesh. Recently, Bangladesh developed an approach of formulating a long-term plan, which would provide a comprehensive solution to the recurrent flood problem and create a climate for sustainable program for economic and social improvement. The approach, called the Flood Action Plan (FAP), will lead to projects which will be technically sound, socially acceptable, environmentally sustainable, economically feasible, and financially implementable. The key elements of the FAP are the concept of control flooding which would allow the desired level of inundation over flood plain but prevent damages, the approach of integrating structural and nonstructural flood mitigation measures, and the concept of compartmentalization for effective flood management. The Action Plan's present activities, covering the five year period 1990-1995, is the first of several stages in the project formulation process. Over the last two years, regional plans are being formulated at prefeasibility level. A number of supporting studies are being undertaken to improve database, develop understanding of the beneficial as well as adverse impacts of flood control projects through evaluation of completed projects, and conduct pilot level activities to try out new concepts and approaches. The FAP is taking a cautious approach in project formulation and their subsequent implementation that will lead toward development of an effective flood disaster mitigation program.

\* Theme Paper

## **FLOOD HAZARD IN THE COASTAL LAND RECLAMATIONS OF HONG KONG**

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The distribution of the flood hazard in Hong Kong including reclaimed areas is described, and case studies are used to illustrate the severity of the hazard. Some observations on the major causes of flooding that include rainfall and storm surges are made. The current flood warning system operated by the Royal Observatory is described and future developments discussed. Engineering practices in relation to flooding are outlined and current projects reviewed. This includes modifying drainage systems to cope with reclamation.

## **UNDERSTANDING FLOOD FORMING MECHANISM FOR BETTER FLOOD HAZARD PREVENTION AND MITIGATION**

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Floods cause deaths and destroy properties. The flood hazard can be minimized by building dams, river normalization, etc., but attained at very high costs. However, floods do occur in developed countries, where funds are available, and therefore raise ambiguity in the methods used for flood preventions or mitigations.

Flood disaster occurs when accumulated river water from rainfall exceeds its channel discharging capacity. The streamflow is affected by rainfall characteristics, basin hydrological conditions, and basin physical parameters, which vary in time and space. However, all discharge calculations disregard detailed basin physical parameters involved. The basin is approached as a unit to simplify the complexity of flood flow calculations. Hence, this approach provides limited information on flood flow mechanism which determines flow discharge at a particular time and location.

The basin segmented "finite-element" approach provides flood flow forming mechanism. Moreover, it can define the lesser from greater influential basin physical parameters on flood flow forming, and therefore provide better solutions to prevent or mitigate flood disasters.

## **POST-CYCLONE RELIEF AND REHABILITATION**

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The coastal areas of Bangladesh are frequently battered by cyclones and their associated storm surges. With a rapidly increasing population, large numbers of people are now settling on lands which are hazardous to habitation. This has increased human and livestock deaths and damage to property. In the absence of any meaningful Land Use Policy, the government has not been able to restrict habitation in the hazardous zone. As a result, post-cyclone relief and rehabilitation requirements have increased beyond the

capacity of the local administration, and every time there is a major storm the central government has to play a major role and, often, international effort is required to save the situation. Relief usually reaches the affected areas 12 to 48 hours after the storm. This causes immense suffering because food stocks have been washed away or damaged, and sources of potable drinking water are grossly inadequate. Aerial relief has been tried out, but this is very expensive and sometimes counter-productive. The only viable solution seems to be to strengthen local administration and local NGO's to distribute relief materials immediately after the storm has abated. Similarly with rehabilitation, outside effort is usually expensive and the solution may be a system by which donors and international relief agencies use the District Administration and local NGO's as their ground-level partners.

## **MITIGATING FLOOD IMPACTS: APPROACHES AND EXPERIENCES IN THE UNITED STATES\***

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Approaches to dealing with floods in the United States have changed dramatically during the latter half of this century. There are several reasons: changes in policies and attitudes resulting from the Nation's experience with actual flood events, development of better trained and more experienced professionals, improved analytical techniques and forecasting measures, and increased capabilities to assess the economic and natural resource losses associated with various uses of the floodplain.

The author reviews current philosophies, policies, and practices for reducing these losses in coastal and riverine floodplains in the United States. Some promising mitigation approaches are presented, based on an extensive 5-year study of progress towards developing a unified national program for floodplain management.

\* Theme Paper