NEPAL

- STATUS OF SEISMIC HAZARD AND RISK MANAGEMENT IN NEPAL

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1 INTRODUCTION

1.1 Location

Nepal is located on the boundary between the Indian and the Tibetan plates, along which a relative shear strain of about 2 cm per year has been estimated. The Indian plate is also subducting at a rate thought to be about 3 cm per year. The existence of the Himalayan Range with the world's highest peaks is evidence of the continued tectonic activities beneath the country. As a result, Nepal is very active seismically.

The topography of the country varies dramatically from the Terai situated on the Ganges plains in the South to the highest Himals in the world bordering the high Tibetan plateau in the North. There have been a number of devastating earthquakes within living memory such as those in 1934, 1960 and 1988. There was a significant earthquake in 1833 and the earliest recorded event in the most comprehensive catalogue to date occurred in 1255. The damage and casualties due to these events have been great. There are frequent small to medium-sized earthquakes in different parts of the country with localized effects. Nepal continues to face a high level of earthquake hazard and risk.

1.2 People and Politics

Nepal, with an area of 149,000 square km, has a population of approximately 19 million of whom about 90 percent live in remote rural areas mostly inaccessible by road. A very recent relatively peaceful democracy movement has seen a progression to a constitutional monarchy.

While there has existed for a long time a full range of government ministries at the national and district levels, urban organizations such as municipal councils have been institutionally very weak. Many international aid agencies are very active in Nepal which has one of the lowest per capita incomes in the world. There is presently much local and central government institutional development going on. Recently, this has included the compulsory retirement of large number of civil servants -- leading to many changes in the senior positions of government departments and allied organizations.

There is no shortage of academically-qualified personnel in the sectors which would contribute to seismic safety. There are a growing number of competent and well-organized private consultancy practices in the scientific and architectural/engineering sector.

1.3 Preparedness

Despite the geological scenario described above, Nepal was relatively late in recognizing the necessity of understanding the seismic phenomena within and close to its boundaries. Similarly, it has only recently appreciated the necessity of a program of earthquake hazard mitigation.

There are no regulations presently enforced in Nepal to govern the design for strength of either private or public structures. While there are competently designed and constructed buildings in Nepal, the majority of structures are, for a variety of reasons, vulnerable to severe damage from relatively minor earthquakes.

The Ministry of Housing and Physical Planning (MHPP) of His Majesty's Government of Nepal (HMGN) is being assisted by UNDP/UNCHS(Habitat) at the moment to define the seismic hazard within Nepal, to develop a national building code, to plan for its implementation, and to recommend alternative technologies and materials. This work is being carried out by a team of national and international consultants appointed in 1992 after a competitive process. The project forms part of a larger effort started after the 1988 earthquake.

2 KNOWLEDGE OF THE SEISMIC HAZARD

2.1 Geological Background

Many geological faults and thrusts and the uplifting of the Himalayan arc have accommodated crustal shortening as the two tectonic plates on which Nepal is astride have collided. The locus of faulting has been initiated on the Indus-Tsangpo Suture (ITS). The major fault activity in Nepal has progressively worked southward with time from the ITS -- first to the Main Central Thrust (MCT), and subsequently to the Main Boundary Thrust (MBT). More recently, the Himalayan Frontal Fault (MFT) is believed to have become increasingly active.

The historical seismicity in Nepal appears to be associated largely with the thrusts. Such seismicity also appears to occur on parallel structures in the crust of the tectonic provinces between the major thrusts, and along transverse structures within the provinces. In addition, historic earthquakes have occurred within the provinces that cannot be readily associated with mapped tectonic structures. The current National Building Code Development Project has compiled maps showing more than 100 active faults belonging to the above-mentioned tectonic provinces.

This scenario explains the high seismicity of the country. A very good understanding of these geological phenomena is essential for any seismic hazard mitigation effort.

2.2 Organizations Studying Seismic Hazard

HMGN Department of Mines and Geology

The Department of Mines and Geology (DMG) has been running a five-station microseismic network in Central Nepal under a French assistance

program since 1978. The program has a target to expand the network to 17 seismograph stations to cover the whole country reasonably during the next few years. The exchange of information in earthquake events is carried out through the International Seismological Center (ISC) and the events of Nepal are entered into the International Bulletins. There are no strong motion instruments active in Nepal.

Ministry of Water Resources

This Ministry has undertaken the seismic hazard assessment of proposed hydropower development sites. It has established local seismograph networks for the assessment of seismicity, but subsequently these have not generally remained active.

Ministry of Housing and Physical Planning

It has been undertaking since the 1988 earthquake an Earthquake Area Reconstruction and Rehabilitation Project with the assistance of UNDP/UNCHS (Habitat). The project seeks to provide material and technical support to the process of reconstruction and rehabilitation of buildings which suffered in that earthquake. Reconstruction of domestic and school buildings has been a major concern. Assistance has been provided to the people in both technical design matter and by way of loans.

The MHPP is also implementing a wider program of Policy and Technical Support to Urban Sector with Habitat's assistance. The National Building Code Development Project is one of the 3 subcontracts of the program. This subcontract, in one of its three sub-components, is undertaking the seismic hazard mapping and risk evaluation of Nepal. This is the first time that there has been a concerted effort to quantify the seismic hazard affecting Nepal. It has collated and re-interpreted existing information on past and potential earthquake sources and developed a seismotectonical model.

2.3 Related Organizations

IDNDR National Committee

HMGN has constituted a National Committee for the International Decade of Natural Disaster Reduction (IDNDR) whose chairman is the Home Minister. Its activities are largely linked to the activities of the Disaster Office of the Home Ministry. Its present composition does not include any of those professionals or academicians who are actively engaged in hazard reduction activities or have the necessary scientific and technological knowledge about the current state-of-the-art in hazard reduction.

The rapidly developing professional societies such as Nepal Geological Society (NGS), Society of Consulting Architectural and Engineering Firms (SCAEF) and Society of Nepal Architects (SONA) are not represented. The IDNDR National Committee has not been able to mobilize available resources for the formulation of national policies, plans or national comprehensive programs and guidelines for reducing the hazard from the various types of natural disasters the country is facing.

It is believed that this lack of action stems from a misunderstanding about the possibilities of hazard mitigation or disaster reduction. Disaster reduction appears most commonly to be understood as those activities geared towards the mitigation of further suffering after the disaster has occurred, neglecting essentially the pre-disaster activities required for effective disaster reduction and mitigation.

HMGN Home Ministry

The Home Ministry's involvement in the Disaster Mitigation Scenario is presented in the organization chart in Figure 1.

A UNDP-financed project of Institutional Support to Disaster Preparedness Plan (NEP/85/002) was implemented during 1989-1992 with the objectives of:

1. Preparation of Comprehensive Disaster Management Plan
2. Establishment of institutional infrastructure on disaster management
3. Development of the core group of trained manpower.

The Comprehensive Disaster Management Plan was prepared and discussed in a national seminar in Kathmandu during August 1991. However, there is no evidence yet of it being implemented.

Nevertheless, this project (NEP/85/002) was successful in imparting training to the officials of the Home Ministry and in setting up an institutional infrastructure within the Special Disaster Unit of the Home Ministry.

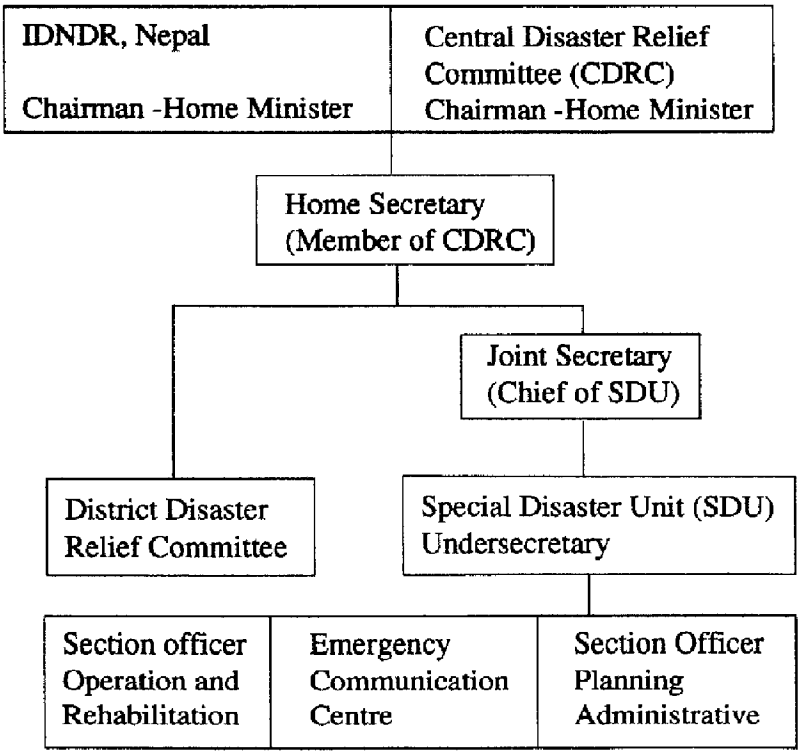


Figure 1: HMGN Home Ministry's disaster organization

Nepal Red Cross Society

The Nepal Red Cross Society has branches in all 75 administrative districts of the country and it is one of the participants in the District Disaster Relief Committees. The Society organizes training and awareness programs regularly.

Nepal Geological Society

The Nepal Geological Society is one of the most active professional groups in the country. On its own initiative it has formed an IDNDR Council which is actively propagating the IDNDR philosophy in Nepal both by organizing scientific forums and by using its publication -- Journal of Nepal Geological Society. The Society also publishes a News Bulletin which carries popular articles.

Tribuvan University

While the Institute of Engineering and the Department of Geology within the university have well-trained staff in structural design, architecture, geology and seismology, there is little evidence of their contribution outside the campus to the national seismic organization. The lack of strong graduate research schools undoubtedly is hindering the anticipated process.

RONAST

The Royal Nepal Academy of Science and Technology (RONAST) is a potentially important organization in the coordination of national efforts in seismic safety. It has a Kathmandu-based Secretariat and a library, and has been further strengthened by an Act of Parliament in 1992. Its main objectives are:

1. Advancement of science and technology for all-round development of the nation
2. Improvement and promotion of indigenous technologies
3. Promotion of research in science and technology
4. Identification and facilitation of appropriate technology transfer.

Its specific functions include:

1. Advising the Government on formulation of technology transfer policy and its implementation
2. Coordinating and implementing science and technology programs with national and international organizations.

National Bureau of Standards and Metrology

The National Bureau of Standards, under the Ministry of Industry, is a member of the International Standards Organization and has published a relatively small number of its own standards. A few of these are relevant to the construction industry. While it is expanding its role, use of its Nepal Standards Mark is voluntary but, once adopted, compliance is enforced. Its library has few up-to-date copies of standards from other countries. A standards expert from UNIDO has been assisting the Nepal Bureau of Standards and Metrology for some years in developing their institutional and measuring capability. It is thought that testing of materials available in

the marketplace, but not claiming adherence to a particular standard, is not undertaken.

IGCP National Committee

Nepal participates in the UNFSCO-sponsored International Geological Correlation Program (IGCP) through the IGCP National Committee under the Ministry of Education. The existing IGCP National Committee is not represented by the professionals actively engaged in the field. This Committee until now does not have any effective communication with the Nepal Geological Society or with the Central Department of Geology of the Tribuvan University. Much is left to be desired to bring the activities of IGCP to public and professional knowledge.

2.4 Regional Programs

SAARC

The South Asian Association for Regional Cooperation (SAARC) is carrying out a Regional Study on Causes and Consequences of Natural Disasters and Environmental Degradation. This is a compilation of write-ups from various national committees of the member countries.

ICIMOD

The International Center for Integrated Mountain Development (ICIMOD), based in Kathmandu, is engaged in various studies related to mountain infrastructure and hazard and risk evaluation. It is developing a large Geographic Information System database it calls MENRIS. It is very well-equipped with hardware and software.

ESCAP

The Economic and Scientific Commission for Asia and the Pacific (ESCAP) based in Bangkok, through its Natural Resources and Environmental Division, provides assistance to Nepal in the field of Geology, Mineral Exploration and Environment.

Currently, DMG geologists are provided with the opportunities of training in Mineral Exploration for Least Developed Countries. Similarly, as part of the ESCAP series of atlases for the countries of the region, the Atlas on Mineral Resources and Geology of Nepal is under publication.

ESCAP has provided opportunities for the geologists of DMG and the University to participate in several training programs, workshops and Expert Group Meetings.

Asian Disaster Preparedness Center (ADPC)

ADPC, based in Thailand, has consistently been very generous in providing training to Nepalese nationals in the field of disaster reduction. This has resulted in strengthening of national institutions to a certain degree.

3 CURRENT RESOURCES AND DEFICIENCIES

3.1 Manpower

There are many well-trained geologists, geophysicists, earthquake engineers, architects and engineers available to form a core group of specialists in seismic safety. Many of these have undergone specialist training in earthquake engineering, hazard mitigation, etc., in various well-known institutions in Japan, USA, Europe, India and Thailand. The Asian Disaster Preparedness Center at the Asian Institute of Technology in Bangkok has provided training in Disaster Management for Nepalese nationals ever since its establishment.

There are a considerable number of engineers trained outside Nepal specifically in anti-seismic design. There are only a handful in practice in Nepal who appear to apply consistently the state-of-the-art in anti-seismic design.

There are a few isolated deficiencies in manpower planning for the future. For example, it appears that there is no one understudying the present government seismologist so there will be a natural continuation in that capability.

3.2 Information

Previous Studies

Nepal is very poorly endowed in secure, yet publicly available, information centers such as libraries and archives. During the data collection phase for the current National Building Code Development Project, many relevant documents describing known previous studies in Nepal have either been unavailable in Nepal, or simply not traceable. This problem is not confined to Nepal's own institutions. A complete set of reports on UN agency-funded studies in Nepal is not available in the UNDP's Kathmandu library.

Journals

Budgetary and financial considerations mean that there are effectively no journals from other countries relevant to seismic safety available within Nepal. This is very discouraging to those who might be enthusiastic enough to want to pursue their interest.

Access to International Databases

The cost of membership and on-line access to international digital database makes their use impracticable. Although the quality of international telecommunications from this part of the world is encouraging to those who try, the related costs and the available mechanism are quite inhibitive.

Geographical Information Systems

Despite the growing interest in Geographic Information Systems in Nepal, and the MENRIS database at ICIMOD, there appears to have been

no attempt yet at coordinating the basic parameters such as accuracy, projection and accepted digital versions of common information such as national and district boundaries.

Bibliography

The National Building Code Development Project is currently preparing a computer-based bibliography of local and international documents relevant to its study. This will be particularly strong with respect to the seismic hazard mapping of Nepal.

3.3 National Coordination of Effort

Management Resources for Post-Disaster Management

The institutional setup for the management part of post-disaster activities appears to be well-organized at the highest government levels. However, frequent transfers of the officials from the Special Disaster Unit (SDU) in the Home Ministry mean there is no continuity of special knowledge. The present SDU consists of officials who were recently transferred from general administration positions. It is anticipated that this practice will continue in the foreseeable future. This dilutes, to a large extent, any effort to establish permanently a core group of specialized and trained personnel so necessary for the successful implementation of the preparedness and post-disaster mitigation plans.

The administrative district organizations suffer from similar problems -- probably on a larger scale than in the head office.

Furthermore, the experience has been that experts in the field of geology, seismology and earthquake engineering are not represented in the preparedness planning, or in the advisory team at the time of the disaster.

Institutional Resources for Pre-Disaster Hazard Mitigation

The available individual institutional resources have been described above. Unfortunately, there appears to be a total lack of coordination among the institutions.

3.4 National and International Networking

There are a number of strong relationships between individual overseas organizations and Nepalese counterparts in fields relevant to seismic safety. Many of these are driven by very specific projects which are part of the overseas organization's research agenda. Others are part of inter-country aid and development programs.

3.5 Professional Development

Advanced Training

Advanced on-the-job training for graduates with geological, engineering and architectural degrees is almost nonexistent. While individual private consultants are beginning to have in-house programs, there is nothing institutionalized from within the professional associations. There is a

considerable amount of training carried out via workshops within Nepal and via externally-sponsored short and long-term courses outside Nepal. The method of selection for these courses does appear to have difficulty in taking advantage of the newly trained on their return to Nepal. For instance, a number of people have been sponsored to the Seismic Disaster Mitigation courses at ADPC in recent years, but it would appear that none of those people has subsequently been able to contribute effectively any progress in this area. Many of them are currently not active in this endeavor.

Self-Regulation and Ethics

The Nepal Engineers Association, an umbrella organization for both architects and engineers from a number of subdisciplines, is reported to have had institutional difficulties in recent years and is not seen as a professional leader. Two recently formed societies have attempted to fill some of the gaps.

The Society of Consulting Architectural and Engineering Firms (SCAEF) has approximately 25 Kathmandu-based members and has subcommittees investigating professional ethics and advanced training.

The Society of Nepalese Architects (SONA) has recently been formed and is accepting the chance to represent the profession on the government committee investigating bylaws.

None of the above institutions has been able to introduce a system of peer-review leading to an accepted professional qualification such as is common in most more-developed countries.

There is therefore no existing infrastructure that would ensure that all design professionals would be obliged to make their clients aware of the importance of anti-seismic features. Similarly, there is no acceptable means by which either the government or the public can judge the competence of design professionals.

4 CURRENT SEISMIC DESIGN PRACTICES

4.1 Building Regulations

There are no regulations presently enforced in Nepal to govern the design for strength of structures. Where clients require design against earthquakes, it is common for the engineer to use the code of the country in which he or she was trained.

4.2 Standard Practice

The standard engineering practice of designing the construction of structures is to follow the Indian Standard Code IS: 1893-1984 which contains seismic design coefficients for the capital, Kathmandu. Coefficients for other areas can be obtained by extrapolation. Although this code does not take into account the specifics of the Nepalese seismic conditions, it has continued to be the standard guideline for Nepalese designers. However, the consideration of seismicity on design is not

mandatory and depends upon the individual initiatives of clients and designers and the availability of funds which generally are scarce. This applies not only to private or governmental buildings and structures. Even the structures donated by international aid and development agencies lack consideration of seismicity in design and construction.

It is thought that there are not any consistent anti-seismic measures applied to the design of bridges.

There is evidence in the streets that the electricity authorities do not practice a consistent approach to seismic hazard mitigation with respect to their lifeline. A number of pole-mounted distribution transformers are not adequately fixed to their mounts.

There have been a small number of site-specific studies to assess seismic risk of proposed hydroelectric dam and important bridge sites.

4.3 Insurance Industry

The concept of insurance against earthquake damage in Nepal is in an embryonic stage. There are cultural and religious reasons why it is not popular. This means that there are no incentives at play that work elsewhere to improve seismic resistance.

5 MOVEMENTS FOR CHANGE

5.1 Building Regulations

The National Building Code of India can, by extrapolation, be used to derive seismic coefficients for Nepal. Of course, unless used consistently with the other requirements of the same code, these coefficients are almost meaningless.

Following the 1988 Udaypur earthquake, there was an attempt within the Department of Building of the Ministry of Housing and Planning to produce in a very short time a Nepal Building Code based on the Indian Code. This ambitious task resulted in some aspects of this effort reaching a first draft stage and there was an industry representative consultative committee formed.

A UNDP/UNCHS(Habitat) funded subcontract is under way within the Ministry of Housing and Physical Planning to define the seismic hazard within Nepal, to develop a national building code, to plan for its implementation, and to recommend alternative technologies and materials. All existing information, including that from previous site investigations, geological surveys and satellite imagery/aerial photography interpretation, etc., has been used in the seismic hazard mapping.

During late January 1993, a committee set up by the MHPP reported on its recommendations after six months of study into proposed planning bylaws for municipalities in the Kathmandu Valley. It presented their proposed bylaws to a workshop that included a wide cross section of interested technical and political authorities.

Building permits within the Kathmandu Valley are presently given on the deposit of simple plans showing the external architectural features of the proposed building. The masons appear to control the design of structures with up to five stories -- often comprising a light concrete frame and unreinforced brick infilled panels and internal masonry partitions. There are many reported instances where a mason has talked the owner out of more appropriate design details by giving inflated estimates of the cost increase.

5.2 Materials Standards

There are a small number of construction materials codes administered by the Nepal National Bureau of Standards and Metrology.

There are standards of all the primary materials available in the marketplace. The average purchaser has no way of differentiating between qualities. Cement and reinforcing steel are both produced locally and imported.

6 RECOMMENDATIONS FOR CHANGE

6.1 National Disaster Mitigation Council Needed

A National Council could address the organization of both the Pre-Disaster (Hazard Mitigation) and Post-Disaster activities. The post-disaster activities could best be coordinated and led by the SDU of the Home Ministry. There should also be an organization promoting Pre-Disaster Mitigation. It could be housed in an existing institution such as RONAST which is already charged with such national responsibilities and has the necessary infrastructure already in place. The main responsibility for implementation should lie with the professional societies such as NGS, NEA, SCAEF and SONA, as well as with the pertinent sections of those government ministries and their departments which are carrying out related programs. One of the main activities of this body would be to formulate drafts of national programs for individual hazards separately and advise the government on how to implement and maintain them. It should also monitor, coordinate and carry out the follow-up work.

6.2 Priority in Strategies

Realization of Fact

Nepal needs to accept that it is located in a high seismicity area and this should be reflected on the government policies for every sector. The National Building Code, under preparation, should be implemented at the earliest opportunity and the commitment made to the necessary ongoing development.

Provision of Training

There is an urgent need for training of senior decision makers. In the short-term, the training curriculum should avoid technical details but should emphasize the following:

1. Pre-disaster mitigation and possibility of better post-disaster mitigation planning

2. Necessity for specialized and trained persons to be included in both stages of the mitigation programs

3. Importance of the involvement of professional scientific and engineering societies in both stages

4. Need to ensure that trained personnel remain in the same fields of expertise and are utilized effectively

5. Training opportunities for non-governmental professional societies and private institutions.

6. Monitoring the services of trained persons and their continued involvement in the respective area of expertise. Follow-up is necessary.

Coordination of Efforts

A great effort is necessary to coordinate effectively the existing resources and the ongoing programs to avoid any duplication and to ensure that the programs actually address the national issues. Subsequent monitoring of the implementation activities is also required.

Professional Development

The membership of the professional societies consists largely of government civil servants, university staff and a small percentage from the private sector, mostly in the consulting industry. The latter are engaged mostly in the infrastructure development sector. Thus, the professional societies are largely patriotic and any assistance accorded to them has a positive return to the country.

Hence, the government will benefit from any expertise available within the societies. Therefore, participation of these societies should be encouraged in all activities of program formulation and implementation.

Responsibilities given to these societies will help them enhance their ability to make technical contributions.

7 THE WORLD SEISMIC SAFETY INITIATIVE AND NEPAL

Nepal is very fortunate in that some of the goals of the World Seismic Safety Initiative (WSSI) have already been addressed by HMGN with the assistance of Habitat.

Possible ways in which the WSSI could help in the mitigation of seismic risk could be by:

1. Helping to draw the Nepalese professional societies, which have been up to now somewhat isolated, into the international mainstream by providing them with opportunities for international exposure and participation in different tasks and the exchange of relevant knowledge

2. Developing a method for the interaction of relevant Nepalese societies with the WSSI and the IAEE member societies

3. Working with the HMGN to strengthen the government's capabilities in seismology

4. Helping to formulate Model Seismic Hazard Reduction programs for developing countries

5. Assisting in establishing networks for the flow of relevant information and literature

6. Organizing international and regional meetings in Nepal

7. Facilitating visits by international experts to Nepal for topical seminars, etc.

9. Special training programs are required to be organized for high level decision makers. ADPC could help, by its training programs, develop understanding of the differences between pre-disaster and post-disaster mitigation activities.

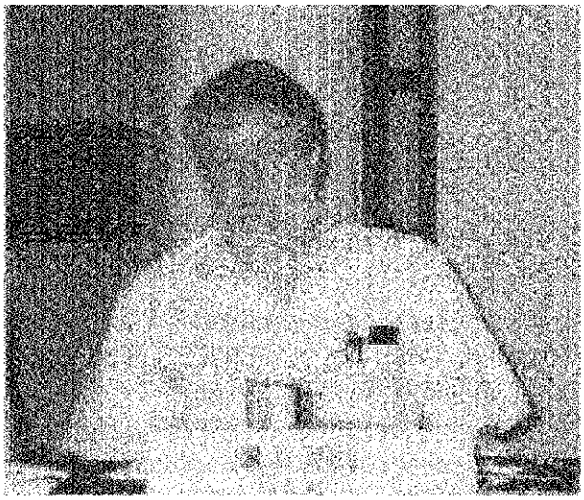
8 SUMMARY

Nepal is, right now, taking many of the steps that the World Seismic Safety Initiative hopes to assist worldwide.

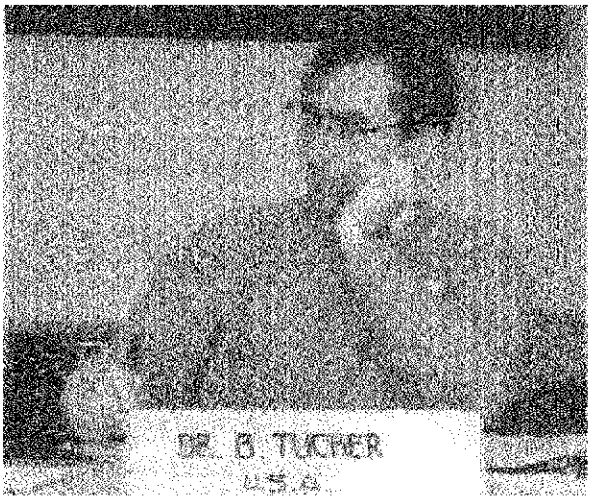
Nepal's needs for access to up-to-date information systems and pertinent literature are greater than its needs for more advanced foreign training for its seismic safety community.

The implementation of a better standard of seismic safety requires the professionals involved in the construction process to adopt proper advanced training methods, peer-review and self-regulation of their professions, along with a Code of Ethics.

A. M. Dixit (Nepal)



C. Thiel (WSSI)



B. Tucker (U.S.A.)

C. S. Yeh (Taiwan)

C. H. Loh (Taiwan)