

## PROCEEDINGS OF THE INAUGURAL CEREMONY

The Chief Guest Mr. Fakhruddin Ali Ahmed, President of India, was received at the V.I.P. entrance of the Vigyan Bhawan and escorted to the dais. The proceedings started with the singing of Indian National Anthem and were carried on according to the following programme:

1. Presentation of Bouquets to the President of India by Prof J.F. Borges, Vice President IAEE and Dr. Jai Krishna, Chairman, Organizing Committee.
2. Welcome to the Guests and Delegates by Dr Jai Krishna.
3. Reading of the messages by Dr. A.S. Arya, Organizing Secretary.
4. Introduction of National Delegates, Honorary Fellows and IAEE Executive by Dr. J.K. Minami, Secretary General IAEE.
5. Dr. E.M. Fournier d'Albe, Director, Science Division, UNESCO Paris spoke on UNESCO interest in Earthquake Engineering.
6. Dr. A. Ramachandran, Secretary, Department of Science and Technology, Government of India, spoke on India's work on Earthquake Engineering.
7. Dr. Shanker Dayal Sharma, Minister of Communications requested the President of India to release the Commemorative Stamp. The President released the Stamp.
8. Shri Hitendra Desai, Minister of Works and Housing requested the President of India to release the Conference Souvenir. The President released the Souvenir.
9. Prof. J.F. Borges, Vice President IAEE, invited the President of India to inaugurate the Conference.
10. Shri Fakhruddin Ali Ahmed, President of India, inaugurated the Conference.
11. Vote of Thanks by Lt. Gen. J.S Bawa, Vice Chairman, Organizing Committee.
12. National Anthem.

### **Welcome speech by Dr. Jai Krishna, Chairman, Organizing Committee.**

Your Excellency Mr. President, Hon'ble Ministers of the Government of India, Distinguished Guests, Delegates to the Conference, Ladies and Gentlemen,

On behalf of the Organizing Committee, it is my proud privilege to extend to you all a very warm welcome to the Conference. I am particularly grateful to our President who in spite of a very busy schedule has graced the occasion. His presence inspires us in our endeavour to understand problems related with earthquakes, a phenomenon which is one of the major natural hazards that the mankind faces today. I also thank the foreign delegates who have travelled long distances to share their experience and knowledge with us.

The year preceding this conference has witnessed a series of major earthquakes in various parts of the world, from Guatemala in the west, Indonesia and Papua New Guinea in the east and China in the north, claiming hundreds of thousands of lives, and billions of dollars worth of property. The psychological impact on millions of people who experienced these earthquakes will remain a nightmare to them for many years to come. It is only appropriate that the scientists from all over the world assemble at these Conferences every four years to study the ways and means of averting the consequences following earthquakes and make life in the seismic areas more and more safe and free of fear.

In spite of intensive studies undertaken in several countries, predicting earthquake ins

space and time still remains a distant goal. However, knowledge already gained has given rise to hopes that prediction will be feasible in the foreseeable future. Towards this objective, every country should strive and study the tectonics, crustal deformations and other features associated with earthquake prediction for the susceptible areas in their country.

The earthquake engineers have focussed their attention on devising methods of strengthening engineering constructions in such a manner that they may withstand future earthquakes. The other direction in which considerable progress has been made is the training of engineers and scientists to be able to make use of these methods. However, in India we have yet to take concrete steps to educate general public living in seismically active areas about the do's and don'ts in the event of an earthquake, with special relevance to schools, theatres and other places, where very frequently large numbers of people gather at one place. This would be a very appropriate work for the National Building Organisation which has already begun with getting a film 'When the Earth Trembles' prepared and shown round the country and I hope they will intensify their activity in this direction to minimise loss and fear in susceptible areas. India has 55% of its area in the moderate to severe earthquake zones.

Another aspect which needs attention is the strengthening of the existing large buildings, dams, factories, etc., and educating their owners about the need to do so. It is common knowledge that only a catastrophe spurs people to undertake such studies. Koyana earthquake of 1967, although of moderate size, started this process to some extent in this country. We had much bigger shocks in 1897 in Western Assam, in 1905 in Himachal Pradesh, in 1934 in Northern Bihar and in 1950 in North Eastern Assam, each with an energy content more than a thousand fold of the Koyana earthquake. However, they failed to arouse the earthquake engineers to the same extent as the Koyana earthquake did. I hope this conference stirs interest in this country still further in taking up the work of checking existing constructions with the help of the latest knowledge and technology so that necessary steps could be taken to strengthen them before an earthquake strikes them.

One would sometimes wonder why all these precautions are necessary because in the last 5000 years the loss of life due to earthquakes on an average is not estimated to be more than about 20 thousand people a year. The number of people that die in road accidents annually is much larger than this, but the loss of property and the psychological impact on the people living in seismically active areas creating fear complex are enormous and necessitate a deeper study into these problems.

In India, reliable records of earthquake damage are available only for the past 150 years and the work of the Geological Survey of India in this respect is indeed commendable. The instrumental data recording is comparatively recent and the India Meteorological Department is rendering very useful service by processing the records and maintaining seismological observatories.

The engineering aspects of the problems, such as methods to strengthen engineering structures, observation of crustal deformation across known faults and collection of strong ground motion data have been undertaken by the School of Research and Training in Earthquake Engineering at Roorkee. Some of the significant contributions made by the School are (i) strengthening of brick buildings against earthquake damage, (ii) manufacture and installation of Structural Response Recorders and Accelerographs, (iii) designing earthquake resistant earth and rockfill dams, water towers, nuclear power plants etc. The School has done significant work in introducing analytical and experimental methods of designing engineering structures for earthquake forces in replacement of empirical methods.

The work of the Roorkee School has been fully utilised in drawing up the codes of practice for the country. It is also providing succour to the Indian Society of Earthquake Technology through technical writings and editorial support. I feel the Government of India took

a step of far-reaching consequence in establishing the School at Roorkee in 1960. It has paid rich dividends by providing the technical know-how in this country and rendering useful service to other friendly countries.

The Conference that our President is inaugurating today is the Sixth in the series, the first one of which was held in Berkeley, United State of America in 1956. This Conference was followed by the next one in Japan in 1960, in New Zealand in 1965, in Chile in 1969, and in Italy in 1973. At Tokyo during the second world conference in 1960, it was decided to form an International Association for Earthquake Engineering. It is under the auspices of this Association that we are holding the Conference this week.

This conference has been organised by the following organisations: (i) Indian Society of Earthquake Technology, (ii) The Institution of Engineers (India); (iii) Central Public Works Department, (iv) Central Water Commission, (v) Corps of Engineers, Indian Army, (vi) Geological Survey of India, (vii) India Meteorological Department, (viii) Indian National Group of International Association of Bridge and Structural Engineering, (ix) National Building Organisation, (x) National Geophysical Research Institute, (xi) Railway Board, Government of India, and (xii) School of Research and Training in Earthquake Engineering, University of Roorkee. Their participation has been of immense help to us. The Department of Science and Technology, Government of India provided the necessary administrative support and guidance for holding the Conference.

Gathered here today are leading personalities from all the countries of the world who have been studying this problem and are contributing effectively to the growth of knowledge. I hope that their participation in this conference will enrich the discussion and add to the knowledge of all the participants. With this hope I have great pleasure in extending once again a very warm welcome to all the delegates. I also welcome once again all other guests who have encouraged us by joining the function this morning.

I would also take this opportunity to thank the International Association of Earthquake Engineering for giving us the opportunity of hosting this Conference. I hope the confidence placed in us by the Directors of the Association and the national delegates from various countries is justified by the service we are able to render through the organising committee.

In the end, I thank our respected President most sincerely for his kindness in accepting our invitation to be with us this morning and I hope his encouragement to us will lead to upgrading the earthquake engineering studies in this country. May this conference be inspired by his presence and render signal service to mankind and be a landmark in the history of growth of Science and Technology of Earthquake Engineering.

Thank you for the patient hearing and I wish all those present and their families a very happy new year.

#### **Messages read by Dr. A.S. Arya, Organizing Secretary of 6WCEE**

Respected Rashtrapatiji, distinguished guests, fellow delegates, ladies and gentlemen:

We have received messages of goodwill for the Conference from high dignitaries, including our respected President, the Vice-President Sri B.D. Jatti, the Prime Minister Smt. Indira Gandhi, the Foreign Minister Sri Y.B. Chavan and the Minister of Works and Housing Sri Hitendra Desai.

I am going to read the messages only from those high dignitaries who are not with us here because the others will be addressing you in person.

*The various messages appear on pages Ivi to Ix.*

**Introduction of Executive Committee Members, Consultative Members, and Participants from Different Countries by Dr. J.K. Minami, Secretary General, IAEE**

Honourable guests and Distinguished participants at this Conference,

I have been asked to say a few words as Secretary General of IAEE. As Prof. Krishna has said, the establishment of the International Association for Earthquake Engineering was discussed at the first World Conference on Earthquake Engineering held at Berkeley, California, in 1956, and the Association was formed in 1960. The aims of our Association are to promote international cooperation in the field of earthquake engineering and interchange of knowledge and practical experience. This is the Sixth World Conference on Earthquake Engineering. The membership of IAEE now consists of more than thirty countries.

At this time I want to introduce the members of the IAEE Executive Committee.\* President Emilio Rosenblueth because of the serious illness of his mother is not able to be here with us. However, we have Prof. Julio F. Borges of Portugal to act on his behalf and Prof. Jai Krishna, Chairman of the Organizing Committee for the Sixth World Conference on Earthquake Engineering. Prof. Sheldon Cherry of Canada, Prof. Luis Esteva of Mexico, Dr. Otto A. Glogau of New Zealand, Prof. Giuseppe Grandori of Italy, Prof. Donald E. Hudson of U.S.A., Dr. Ali A. Monifar of Iran, Prof. Sviatoslav V. Poliakov of USSR and Prof. Hajime Umemu of Japan are the Directors of IAEE who are attending the conference. Those who are not present are Prof. Nicholas N. Ambraseys of U.K., Prof. Arturo Arias of Chile and Prof. Georgi Brankov of Bulgaria.

On the other hand, we have Prof. George Housner, an Honorary Member present at this Conference. Also, Prof. Ray W. Clough of the University of California, Berkeley is with us. Honorary Members Prof. Muto, Prof. Nathan M. Newmark and Prof. John E. Rinne are not able to be with us but they have expressed best wishes for the success of this Conference.

Let me read out the name of each country which is represented here and I wish that the participants from each country would kindly stand up (please see page clvii).

With this I shall conclude my remarks and let us get down to the real work of Conference.

**Speech at the Inaugural Session of the Sixth World Conference on Earthquake Engineering, by E. M. Fournier d'Albe, Director, Science Division, UNESCO**

Mr. President, Ladies and Gentlemen,

It is my pleasant duty to bring to you, Sir, and to the delegates to this Sixth World Conference on Earthquake Engineering, on behalf of the Director-General of Unesco, his greetings and his best wishes for the success of this Conference.

It is of special significance that this Conference is being held in India, not only because parts of your country, Sir, are subject to destructive earthquakes but because Indian scientists and engineers have made outstanding contributions to our knowledge of earthquakes and of the means of protection against them. The School of Research and Training in Earthquake Engineering at the University of Roorkee is known throughout the world, and it is a special pleasure for me today to greet its founder, Professor Jai Krishna, who, in addition to his many other responsibilities, presided over the Intergovernmental Conference on the Assessment and Mitigation of Earthquake Risk, held at Unesco Headquarters in February of last year.

This Intergovernmental Conference was the culmination of fifteen years of concerted efforts by Unesco and its Member States—efforts to improve the basic seismological observatory net-

\*List of members of Executive Committee of IAEE for the period 1973-77 appear on page clxxxi.

## NATIONAL DELEGATES/REPRESENTATIVES INTRODUCED

<i>Sl. No.</i>	<i>Name of the Country</i>	<i>Name of the National Delegate/ Representative</i>
1.	Argentina	Juan Carmona (Absent)
2.	Australia	Charles Bubb
3.	Austria	Rudolf Grossmayer
4.	Belgium	D.K. Shukla
5.	Brazil	F.V. Filho
6.	Bulgaria	S. Sachanski
7.	Canada	Sheldon Cherry
8.	Chile	Rodrigo A. Flores
9.	Checkoslovakia	Emilia Juhasova
10.	El Salvador	J. Amaya G. (Absent)
11.	France	J. Despeyroux
12.	Germany (West)	Gerd Winkel
13.	Germany (East)	K.H. Hofer (Absent)
14.	Ghana	N.O. Henaku (Absent)
15.	Greece	Roussopolous
16.	Indonesia	Teddy Boen
17.	India	Jai Krishna
18.	Iran	A.A. Moinfar
19.	Iraq	S.A. Alsinawi
20.	Italy	G. Grandori
21.	Japan	Keizabro Kubo
22.	Mexico	L. Esteva
23.	Nepal	Anand Panchdhari
24.	New Zealand	O.A. Glogau
25.	Nicaragua	Armando Hernandez
26.	Peru	J. Kuroiwa
27.	Philippines	A.R. Flores (Absent)
28.	Portugal	J.F. Borges
29.	Rumania	G. Serbanescu (Absent)
30.	Spain	J.L. Justo
31.	Switzerland	Jost Studer
32.	Turkey	R. Yerar
33.	U.K.	David J. Dowrick
34.	U.S.A.	H.J. Degenkolb
35.	U.S.S.R.	S.V. Poliakov
36.	Venezuela	Alberto E. Olivares
37.	Yugoslavia	Sergei Bubnov

works (for instance, in South-East Asia), to organise the analysis of seismological data on a global scale (by the creation of the International Seismological Centre), to confront this data with the geological evidence of past seismicity and thus to define and quantify the risk in terms useful to engineers and planners (I refer, for instance, to the Survey of the Seismicity of the Balkan region), and above all to foster the training of the specialists so urgently needed in the developing countries (as at the International Institute of Seismology and Earthquake Engineering in Tokyo, and the Institute of Earthquake Engineering in Skopje, Yugoslavia, in whose activities the scientists and engineers from the School of Earthquake Engineering in Roorkee have played an important part).

The Intergovernmental Conference reviewed past progress and present knowledge, but also brought out clearly the complex nature of the problems which remain to be solved, especially in those developing countries which lie within the world's seismic zones. It is now clear that the loss of life and terrible destruction caused by earthquakes will only be reduced by concerted action in each country, involving scientists, engineers, planners, architects, economists, sociologists, civil defence specialists, and bringing into play decision-making processes at the highest level of government.

However, it is to the earthquake engineers that we look for the final solution to the earthquake problem, for this will be achieved only when every house, every building and all the other works of man in the world's seismic zones will have been designed and built, or strengthened to resist earthquakes successfully. Progress in this field will depend on a full and free exchange of knowledge and ideas, and Conferences such as this are a vital element in this exchange.

The International Association of Earthquake Engineering, under whose auspices this Conference is held, has been closely associated, since its formation, with the work of Unesco. We have in the past, and shall in the future, look to it for the advice and guidance which it is uniquely capable of providing.

Mr. President, this Conference is being held after a year during which earthquakes have inflicted unprecedented losses on mankind. In one single earthquake last year, many hundred thousand people died. Another caused heavy casualties, and damage amounting to more than the annual budget of the government of the country concerned.

One can no longer ignore the magnitude and urgency of the task before us, nor the heavy responsibility that lies upon our shoulders. If this Conference can bring us one step nearer to our ultimate goal of rendering earthquakes harmless, it will have been worth all the efforts and resources that have been put into its organisation. I wish it all success.

**Speech by Dr. A. Ramachandran, Secretary, Department of Science and Technology, Government of India:**

Your Excellency Mr. President, Hon'ble Ministers, Dr. Borges, distinguished delegates, ladies and gentlemen.

On behalf of the Government of India it is a matter of great pleasure for me to welcome you all to this historic city of Delhi which I may mention also lies within the seismic zone of this country and, therefore, I feel that the Sixth World Conference is being appropriately held in this great city. The Department of Science and Technology is intimately associated with many activities in the field of seismology and earthquake engineering. Although I am not a specialist in this particular area, I would like to share some of my thoughts with you this morning. The spinning globe, the earth with its atmosphere has its own significance and interest for different kinds of natural scientists. While geologists are interested primarily with the study of the earth's crust, geophysicists delve deeper in order to understand the nature and the structure of the earth beneath the crust. One often hears the earth being referred to as a quiet and inert mass. This is far from

the truth when one realises that the earth is shaken by frequent catastrophic earthquakes and there are many microearthquakes that take place in the crust every day. In an average year it has been computed that there are at least ten earthquakes causing widespread death and devastation, about a hundred others causing serious local destruction, thousands do some damage and a hundred thousand strong enough to be felt as tremors and a million can be detected by seismographic instruments. In other words, a seismic havoc occurs every thirty seconds somewhere on this planet and it is in this context that an intensive study and research in the field of earthquake engineering has assumed even greater importance today than ever before. Despite important advances in science and technology, our power to combat earthquake has remained somewhat meagre. It is known in earthquakes involving apparently quite small movements, the volume of material moved is enormous and the energy released is correspondingly enormous. Perhaps the biggest difficulty in achieving earthquake resistant-construction lies in not being able to describe adequately the nature of ground oscillation. Earthquakes are so variable that each major earthquake breaks many patterns of previously observed behaviour and some time after their occurrence each one is considered unique and quite unlikely to happen again. Theoretical studies and close observation of the effects of actual earthquakes and experimental work have revealed the constructional demands for earthquake resistant structures. Study and research in the field of earthquake engineering is of special significance to India since about half of its total area of 3.3 million square kms lies in the seismic zone. This is about 11 times the seismic area of Japan and California put together.

The country has experienced six major earthquakes, the last major one being in Koyana of 1967. Unfortunately in India we have only a continuous recording of earthquakes for the last two hundred years, when one realises that barring the central part of the Deccan plateau and small areas in Rajasthan and the Indo-Gangetic belt, there are hardly any regions of our country which are totally free from seismic activity. In order that engineers are able to contribute effectively by improving the design of structures resistant to seismic activity, it is desirable to have a network of seismological observatories in the country which would be capable of monitoring earthquakes occurring anywhere in the country as well as recording in precise terms shocks of lesser magnitude in its vicinity. The Department of Science and Technology, in co-operation with the India Meteorological Department and other concerned agencies, is engaged at present in the task of creating a network of such observatories which would be equipped with the latest instrumentation. This, one day, we hope would be part of the global network, so that scientists in other countries would be able to have a deeper understanding of the nature of earthquakes.

It is interesting to note that the possibility of foretelling the occurrence of natural phenomena, including earthquakes, has fascinated man for many thousands of years and has occupied as much intellectual endeavour recently as planetary orbits four hundred years ago and sun rise four thousand years ago. Although earthquakes are as ancient as the earth itself, only a few countries which suffer from disastrous earthquakes have been able to mount a tremendous technological and logistic operation that detailed predictions required. Available evidence seems to indicate that earthquake prediction is a complicated task and would need a multi-pronged attack if one is to anticipate the outbursts of these terrestrial brats. In order to enable engineers to plan and design buildings, dams and reservoirs, it would be necessary for them to have a fuller knowledge of earthquake behaviour based on as much seismological information as possible. One can confidently say that there is at present no alternative to the use of sophisticated instrumentation to get all relevant information in order to understand earthquake behaviour, though one of the countries seems not to have used sophisticated technology in the programme of prediction of earthquakes.

Although some aspects of earthquake engineering were studied by our civil and particularly structural engineers in our premier institutions, systematic efforts in this field were initiated at the University of Roorkee in 1958. The University under the leadership of Prof. Jai Krishna, was the

first to focus the attention of engineers on various aspects of earthquake engineering problems. The Roorkee University has organised the School of Research and Training in Earthquake Engineering which has become an internationally recognised centre of excellence in this field. There is an increasing awareness not only among the members of the engineering fraternity but also the public at large to adopt earthquake-resistant designs of engineering structures. As a result of the pioneering efforts of the Roorkee University other institutions in the country have got themselves interested in matters such as earthquake resistant construction of buildings, design of multistoreyed buildings, design and construction of bridges, dams, power stations and industrial plants.

As stated earlier, since 55 per cent of India's territory lies in the seismic zone, the design of such buildings involving high technology has assumed greater urgency. It is necessary, in my view, to have guidelines and codes for a seismic design of petro-chemical plants, oil refineries and nuclear power projects. Of the latter several countries, including our own, have provided necessary guidelines. The purpose of a seismic design of industrial facilities such as nuclear power plants is to avoid hazard to the environments, including the public. Equal attention will have to be paid to some of the industrial facilities such as power networks, conventional power stations and telephone networks that are required to maintain continuous operation during a destructive earthquake for the security of society. In India such a code for earthquake-resistant design was first published in 1962. This was again revised in 1966, 1970 and 1975 in the light of new studies in these fields. Besides this code of design, code of practice for earthquake-resistant construction of small buildings in brick-work, masonry and timber has also been published.

I am happy to say that the Department of Science and Technology has taken a keen interest in this important field and has given substantial support for the setting up of strong motion accelerographs and structural response recorders in the actual seismic zones in this country. It is hoped that these will provide data required for the economic design of earthquake-resistant structures. The Department at present is also compiling a project for surveying seismicity and the seismotectonics of the Himalaya, extending from the Western Himalaya to the Arakan range. Under this project which would involve all institutions and organisations doing work on one or other aspects of seismology it is proposed to set up a network of 18 seismic stations and 18 accelerograph stations which would be in addition to the present plan of extension of the existing network. It is our hope that the data collected would be of real value in solving the pressing problems of earthquake engineering in that region. This would also be of the highest significance to our scientists and engineers in the field of seismology and earthquake engineering.

In India there is no question of lack of financial resources or scientific expertise to mount an earthquake protection programme similar to that currently being launched in the United States and the USSR. This will help, to a great extent, in the precise forewarning of an impending disaster. It will also add to the sense of security and happiness of the vast multitude of people who live at the moment in constant fear and uncertainty. It would also uplift their morale. This would make them contribute better to the national prosperity. Although some governments, notably the United States, Japan, the USSR and China are paying necessary attention to the problem of earthquakes and earthquake engineering, the total effort on a global basis is minute when compared to the magnitude of the problems involved. In many countries adequate attention is not devoted to this aspect in spite of its great importance. More seriously architects often opt for aesthetics over seismic stability. Thus the earthquake problem is not only for seismologists and structural engineers. Structural engineers should be educating architects, engineers, planners and administrators in the great need for their effective participation. Earthquake resistant measures can be adopted with only an increase in the cost of structures of about four to six per cent of the cost of buildings and other constructions. This additional cost is well worth the safety provided.

In February 1976 UNESCO convened an inter-governmental conference to consider all

aspects of engineering seismology. It recommended the setting up of a joint committee for the assessment and mitigation of earthquake risks and for the preparation of an inter-disciplinary programme in this particular area. In this context the Sixth World Conference on Earthquake Engineering will be an important milestone in man's quest for developing techniques for predicting earthquakes and for mitigating the sufferings caused by earthquakes, and last but by no means the least, relieves the people living in seismic zones of uncertainty and fear.

We in this country look forward to the proceedings of this World Conference.

Thank you.

**Speech by Dr. Shanker Dayal Sharma, Minister of Communications Requesting the President of India to Release the Commemorative Stamp:**

Your Excellency President of India, Hon'ble Shri Hitendra Desai, Dr. Borges, delegates, ladies and gentlemen:

It is my privilege to be associated with this function, when the President of India will inaugurate the Sixth World Conference on Earthquake Engineering and also release the special postage stamp brought out by the Posts and Telegraphs Department to mark the occasion.

From the dawn of civilisation man has been grappling with the vagaries of nature and trying to harness the natural resources. As we are all aware, nature is bountiful and provides the basic necessities of life. But mankind has also to face such menaces as floods, droughts, cyclones and earthquakes. Now and then we hear of reports of occurrences of earthquakes which take a heavy toll of human life and render several thousand people homeless. It is difficult even to imagine the extent of suffering and hardship caused by these natural calamities unless one really experiences them. Viewed in this context the work done by institutions such as the International Conference on Earthquake Engineering and the regular work done by engineers and scientists assume great significance. I am happy to note that extensive research is being done in India in the field of tectonic and seismological problems by the Geological Survey of India, the Meteorological Department and the School of Research and Training in Earthquake Engineering in the University of Roorkee. The basic aim of science is to unravel the mysteries of nature and make life more comfortable and a more happy place to live in. The tremendous progress achieved by man in the field of science and technology has brought about a fulfilment of these objectives to a great extent. At the same time, it cannot be taken for granted that scientific progress will bring in only peace, prosperity and happiness. History bears testimony to the fact that if scientific knowledge is not properly utilised, it can lead to human misery and destruction of life. Viewed in this perspective, a heavy responsibility rests on scientists, technologists, statesmen and administrators, in order to ensure that scientific knowledge is deployed only for peaceful purposes and for furthering human welfare. This World Conference has, therefore, appropriately been dedicated to human welfare.

In this context we might recall that Pandit Jawaharlal Nehru, who was a person with a great vision and a profound sense of history, firmly believed that the future of the entire humanity lay in the hands of scientists. Since the attainment of independence India has laid great emphasis on science and technology. Along with this there is also the imperative need to develop a scientific temper and outlook among the large masses of our people, particularly those living in the rural areas. Such a transformation can only come about by making scientific research more broad based.

I believe that this Conference on Earthquake Engineering will devote itself to the important aspect of earthquake occurrence and preventive and remedial measures in regard to them. It has a special significance for India which has fifty per cent of its area located in active seismic zones.

I am sure the deliberations of this Conference will lead to further dissemination of know-

**Sixth World Conference On Earthquake  
Engineering  
COMMEMORATION STAMP  
10.1.77**

The Sixth World Conference on Earthquake Engineering, was held at New Delhi from January 10 to 14, 1977 under the auspices of the International Association for Earthquake Engineering. The invitation for this was extended by the Indian Society of Earthquake Technology and the Institution of Engineers (India). Several other Government departments and organizations are co-sponsors of the Conference.

The Conference was one in a series held every four years. The first Conference was held in 1956 at Berkeley. The scope and participation in these conferences have gradually increased and they have played an important role in furthering research studies in the field of earthquake engineering. The Conference brings together seismologists, geologists and engineers to discuss the problems of earthquake hazards like their prediction, mitigation of risk, design of various engineering structures for earthquake resistance, rescue operations, etc.

The Conference had special significance for India which has about 55% of its area under seismic zones. The Geological Survey of India and the India Meteorological Department have been studying tectonic and seismological problems for long. For studying the engineering aspects, the School of Research and Training in Earthquake Engineering was established in 1960 at the University of Roorkee, Roorkee. With the co-operation of these and other organisations, the first code of practice for earthquake resistant design of structures was published by the Indian Standards Institution in 1962. The code has since been updated three times and used extensively. Earthquake engineering studies have now made substantial advance in India and the country was proud of hosting the Sixth World Conference on the subject.

The Post and Telegraph Department was happy to bring out a commemorative stamp to mark this occasion.



नई दिल्ली  
NEW DELHI  
10-1-77  
संविधान सभ

**तकनीकी आंकड़े  
TECHNICAL DATA**

जारी करने की तारीख Date of Issue	...	10-1-1977
मूल्य वर्ग Denomination	...	200 P.
कुल आकार Overall size	...	3.55 × 2.90 सेंमी. cm.
मुद्रण आकार Printing size	...	3.55 × 2.50 सें.मी. cm.
प्रति शीट संख्या Number per issue sheet	...	35
रंग Colour	...	नीलरक्त Plum
छिद्रण Perforation	...	13 × 13
जलचिन्ह Watermark	...	बिना जलचिन्ह वाले विपकने वाले डाक-टिकट कागज पर मुद्रित Printed on unwater- marked adhesive stamp paper
मुद्रण प्रक्रिया Printing process	...	फोटोग्रेव्योर photogravure
मुद्रित टिकटों की संख्या Number printed	...	20,00,000
डिजाइन और मुद्रण Designed & printed at	...	भारत प्रतिभूति मुद्रणालय India Security Press

**DESCRIPTION OF DESIGN**

The design of the stamp shows symbolically the seismogram on a recording drum. The split in the earth's crust represents the faulting responsible for earthquake occurrence.

ledge already acquired and open up new vistas of research and studies on this complex natural phenomenon.

The Posts and Telegraphs Department is privileged to be associated with the holding of this Conference by bringing out a special postage stamp. We feel honoured that the President of India is formally releasing the special stamp on the occasion of the inauguration of the Conference.

I would now request the President to release the stamp.

*His Excellency Mr Fakhruddin Ali Ahmed, President of India, then released the stamp by opening the Album and showing it to the audience. The stamp and its write-up are presented on p. clxii.*

**Address by Shri Hitendra Desai, Minister for Works and Housing Requesting the President of India to Release the Conference Souvenir**

Respected Rashtrapatiji, distinguished delegates, ladies and gentlemen.

The holding of the Sixth World Conference on Earthquake Engineering in New Delhi is an event of international importance. It signifies our growing concern to meet the challenge of earthquakes which occur frequently in many parts of the world causing great sufferings and loss of lives and properties. By application of modern scientific knowledge, it is possible to minimise to a great extent, the damage and destruction that occur in the event of earthquakes.

Buildings, houses and other structures that are required to fulfil our modern day needs, are being constructed in large number all over the world, specially in the developing countries in the wake of rapid programme of urbanisation and industrialisation. In areas that are prone to earthquakes it is incumbent to design and construct such buildings and structures so as to resist the seismic forces. Technologically it has been made possible to achieve this but at the same time what is of crucial importance is that we should be able to do so at an economical cost. Great care has, therefore, to be exercised in arriving at a compromise solution whereby certain calculated risks are taken to keep the cost of construction low yet ensuring adequate safety of the buildings. Intensive research and investigations are called for to have required scientific and technical data regarding the occurrence of earthquakes and performance of buildings and structures, on the basis of which appropriate designs and construction techniques could be adopted.

The various Ministries of Government of India and Government Departments undertaking construction of different kinds, including the Ministry of Works and Housing, which I have the privilege to represent, are making all efforts to give due attention to design of earthquake resistant buildings, houses and other structures. The National Building Organisation of my Ministry which is also functioning as U.N. Regional Housing Centre of ESCAP, is engaged in promoting research and application of results in practice. It is creating greater awareness to meet the challenge of earthquakes in the field of housing and building construction.

The efforts that are being made in this direction in India by various institutions and organisations, have been briefly indicated in the Souvenir, which has been brought out on the occasion of this world conference.

May I, on behalf of you all, request our respected Rashtrapatiji to kindly release the Souvenir.

Jai Hind.

*Sri Fakhruddin Ali Ahmed, President of India then released the Souvenir Volume by showing it to the audience.*

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**Speech by Dr. J.F. Borges, Vice President IAEE Welcoming the Chief Guest to Inaugurate the Conference**

Your Excellency Mr. Fakhruddin Ali Ahmed, President of India, Dr. Jai Krishna, Chairman of the Organizing Committee, Sixth World Conference on Earthquake Engineering, Distinguished Guests of Honor, Fellow participants in the Conference, Ladies and Gentlemen,

When closing the Fifth World Conference on Earthquake Engineering four years ago my predecessor, Dr. George Housner, perhaps jestingly, forecast that between the Fifth and the Sixth World Conferences there would be twelve damaging earthquakes, of which four would result in major disasters. If we interpret the words "damaging" and "major disasters" adequately we see that the prediction was accurate. Congratulations, Dr. Housner!

These four years have been exceptionally active seismically the world over; 1976 in particular surpassed all estimates that could reasonably have been based on average seismicity in the last decade. We expect to learn much from these events at the conference that begins today. Not only has world seismicity been high but its effects have been more devastating than in previous years: the number of earthquake victims since the last conference greatly exceeds the number of victims in any other four-year period during the last half century; material losses are proportionally higher. On the other hand the number of strong-motion instruments has trebled since the Fourth World Conference and, in one respect, some temblors have been docile: they have struck sites with profuse instrument deployment and where accelerograph maintenance has been exemplary. We thus accumulated more records, trustworthy records, between the Fourth and Fifth Conferences than in the entire prior history of mankind, and so the interval between the Fifth and Sixth Conferences has seen the interpretation of more data than had been possible up to then. Qualitatively also, interpretation of the meaning of these data and of sundry recent measurements is much deeper than was possible just a few years back, as we begin to understand generating mechanisms, effects of wave path and local geology, and the behaviour of structures. In one instance—that of the 1975 Haicheng earthquake—a major disaster was averted thanks to timely prediction and intelligent action; prediction opens new avenues of research interesting to all concerned. We therefore have much to look forward during this short week in New Delhi.

The pace of progress in our field has vigorously accelerated. No soon is a book on the subject out from the press that it is obsolete. Vastness of present production is such that it has become impossible to follow even the highlights of what goes on in countries other than our own. World conferences acquire thus a much stronger *raison d'être* than they had twenty years ago when the first was held in California. They afford the one effective means for looking into the most outstanding contributions being made in the entire world and for talking intimately with the most distinguished contributors to the field.

Most participants have travelled from afar to learn. Frankly we expect to learn much more than lessons from destructive motions and spectacular advances in experimental and analytical methods. We will also learn a bit about the oldest continuously live civilization on earth, the one most deeply impregnated with mysticism, wisdom, and man's knowledge about man. A civilization that has enchantment and flavour; the one that has taught humanity the meaning of dignity. There are reasons to hope that people who have so generously given to the human race will delve into earthquake engineering and inject into it new viewpoints and furnish new insights; glancing through preprints opportunely distributed by the organizers, we once more confirm the high quality of Indian contributions; and we like to think that interchange of experience and ideas will be mutually beneficial: the local specialists will also find their outlooks significantly enriched. But quite egotistically we cannot hide our eagerness to come into contact with Indian people and Indian cultures. We know the Organizing Committee has engaged in tremendous efforts to make

this too, the less technical and more human aspect of our visit, deeply gratifying.

In thanking the local organizations and individuals who make this magnificent event possible their gracious and effective strife, which even at this early stage promises to be brilliant, I respectfully ask His Excellency, President Fakhruddin Ali Ahmed, to declare the Sixth World Conference on Earthquake Engineering inaugurated.

#### **Inaugural Speech by Mr. Fakhruddin Ali Ahmed, President of India**

Dr. Borges, Dr. Jai Krishna, Dr. Shanker Dayal Sharma, Mr. Hitendra Desai, Ladies and Gentlemen,

It gives me great pleasure to be here this morning to inaugurate the Sixth World Conference on Earthquake Engineering. I extend a hearty welcome to the distinguished delegates attending this Conference particularly to those who have come from abroad. I hope they will find their stay useful and interesting.

It is indeed appropriate that this International Conference is being held in India. We have, in recent times, witnessed some of the severest earthquakes of history. To remind you, the most recent great Indian earthquake occurred on August 15, 1950 in Assam. I had the opportunity of visiting the affected parts at that time. Having spent a substantial part of my life in Assam, I am associated closely with earthquake occurrence, resulting fears from them and yet getting accustomed to tremors every now and then. This particular earthquake was associated with large scale fissuring of ground, major changes in river-bed levels and their courses, landslides, damage to road, rail tracks, bridges etc. Yet, fortunately for us, less than 2000 lives were lost. This was so because the affected area was mostly undeveloped and very sparsely populated. With the passage of time, the world population is gradually increasing, the investments in construction industry are growing more, and more industries are being set up to meet the increased demand. All these developments are therefore steadily increasing the potential of hazards during future earthquakes.

I hope you all will agree with me that amongst the natural hazards like cyclones, storms, floods, volcanic eruptions, earthquakes, etc. the rate of destruction of life and property associated with earthquakes is perhaps the most rapid. Also the total duration of the fury is so short that it does not permit timely observations and necessary remedial actions. This also makes the task of the technologists more difficult. Whatever be the limitations, the world societies look forward to you for the timely safeguard of life and property from the wrath of the earthquakes.

It is indeed unfortunate that in most of the countries the occurrence of the large-scale loss of life and property during some major events alone has focussed the attention of respective governments to provide greater support for earthquake studies.

In India, the Koyana earthquake in the last decade brought home to all concerned the need for greater attention to this matter. I earnestly hope and wish that, from now on, the timing of increased inputs to earthquake engineering studies will coincide with holding of conferences like this rather than with occurrence of disastrous earthquakes. If this is achieved your deliberations here will undoubtedly be a landmark in the history of meeting the challenge the earthquakes pose.

The last couple of years have been marked by uncommonly large number of damaging earthquakes in the world. The Tangshan earthquake in China during July 1976 has taken a very heavy toll of lives. This was so even when the knowledge of prediction of earthquakes has made considerable progress in China.

We, in India have been quite alive to the problem of earthquake hazard. The entire northern border areas of our country are highly seismic and there is no place where the earthquake risk can be wholly discounted. The Geological Survey of India, India Meteorological Department,

and the School of Research and Training in Earthquake Engineering at the University of Roorkee, have been studying earthquakes and related problems and have contributed to the know-how in this field substantially. There are some other institutions also doing work on this problem. I am sure that the Indian scientific community engaged in this work would amply gain by this Conference in which I am happy to learn many leading scientists and engineers engaged in research in this field are participating.

One of the important problems before the earthquake scientists today, which has evoked considerable amount of interest amongst the public as well, is that of earthquake prediction. It is difficult for me to estimate as to what extent the losses due to major earthquakes can be minimised even if reliable short range earthquake predictions with regard to their size, time and place were made available. Timely precautions may permit a substantial reduction in the loss of life even though the saving in indirect losses may only be marginal.

I am sure it is appreciated by scientists that lack of accuracy in prediction has socio-economic and moral implications of great magnitude and therefore, great care need be exercised before the general public is taken into confidence in this respect. However, long range predictions may permit adequate safety measures while designing and constructing new structures and even strengthening the existing ones. This may be able to reduce the hazard considerably.

As I understand, most of your attention is devoted to the economical and safe design of major structures. May I urge you to give some of your expert thoughts to the economical methods for earthquake-resistant design and construction of small residential buildings as this has great importance for developing nations like ours. This may be done not only for the newer construction for mass housing but means also may be devised to strengthen the existing houses. May be, this involves greater study of the regional design and construction techniques for reasons of economy. This I am sure is an easy task for you all but will be of great service to humanity.

May I also add here the need for consideration to the existence of a number of historical monuments especially in countries with rich cultural heritage, like ours. Several of these are very old and have withstood the test of time with little or no damage. Yet it is time that we thought of suitably strengthening them against the forces of future earthquakes. A very important aspect to reduce losses during an earthquake is to educate the masses-both regarding what to do during an earthquake and as to how the rural buildings can be made earthquake resistant by the smallest of changes in the traditional construction techniques.

I have great pleasure in inaugurating the Conference and I wish your deliberations all success.

Jai Hind

#### **Vote of Thanks by Lt.-Gen, J.S. Bawa, Vice-Chairman Organising Committee**

Your Excellency Mr. President, Hon'ble Ministers, distinguished guests, ladies and gentlemen:

I have now a very pleasant and brief duty to perform in proposing a vote of thanks. First and foremost, Your Excellency Mr. President, Sir, we are honoured by your presence. We are grateful to you for inaugurating the Conference and for encouraging us.

We are grateful to the Hon'ble Minister of Communications and the Hon'ble Minister of Works and Housing for having been with us and for all the help which they have given us.

We are grateful to the International Association for Earthquake Engineering for holding this Conference in India and thereby giving us a chance not only for exchange of valuable technical information but also for giving us the pleasure of hosting them.

We are grateful to the distinguished guests who have spared the time to be with us, the distinguished authors who have come from far and distant parts of the world and others.

*The inaugural ceremony came to a close after the Indian National Anthem was sung and the Chief Guest was escorted back to the VIP gate of Vigyan Bhawan for departure.*