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PREPAREDNESS AND MITIGATION OF EARTHQUAKE DISASTER

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INTRODUCTION

Earthquakes have claimed a large number of human lives over the history of mankind. The Bihar-Nepal earthquake of 1988 is a very recent experience which has caused untold miseries to many. A major earthquake adversely affects practically all facets of human activity and jeopardises the total functioning of the society, besides becoming a big economic burden on the country taking back its development by several years. Earthquakes are known for their suddenness in occurence and severeness of losses. Devastating destructions can take place in a matter of few seconds without any prior warning. The losses caused by an earthquake include collapse of land massess, houses, work places, schools, colleges, hospital buildings and damage or failure of dams and reservoirs and critical facilities involving hazardous substances. Each of these actions may result in heavy loss of human/cattle lives. Although the occurence of earthquakes is not restricted to any particular region or society, the rural poor and under-privileged masses are invariably the most vulnerable and always the worst hit. It is true we cannot stop the occurence of this natural phenomena causing disasters, but surely their impact on human life and property can be considerably reduced through protective, preventive and ameliorative planning measures.

ROLE OF MITIGATION

All of us are aware of how the tectonic earthquakes occur and how they cause damages to or failure of the structures. We are also aware the occurence of these earthquakes cannot be prevented. If it is possible to predict the seismic event in respect of time and magnitude it is certainly possible to drastically reduce the loss of life by organising timely evacuation. Unfortunately with the knowledge available today a reliable prediction of earthquakes is not possible. Even if this is achieved, the organisational and logistic problems associated with such an action would be unsurmountable and still we would not be avoiding the loss of property and destruction of facilities. The appropriate philosophy to mitigate the effects of this natural disaster is to aim at proper preparedness to face it, and a meticulous management programme to deal with the emergency, when the disaster strikes.

ELEMENTS OF MITIGATION

Mitigation of an earthquake disaster should take into account of many intricate aspects keeping in view of the physical and social set-up, communications and other logistics. The fact that an earthquake gives very little or no alarm should be kept in mind while formulating a mitigation programme. The object of a 'disaster management programme' should be to avoid deaths, reduce injuries and property damage and minimise the disruption of a community's social and economic fabric. It is also necessary to attend to the specific needs of the poorer sections of our society. It is considered that by adopting a strategy of both short-term and long-term measures we will achieve compatability in loss minimisation. The short-term measures are aimed at an immediate attention to minimise the loss potential in the wake of a sudden earthquake. These measures may include protecting and upgrading of poorly

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built structures, seismic safety evaluation of dams and other vulnerable facilities, preparing emergency plans, establishing contigent funds, creating public awareness etc. The long-term measures will include identification of potentially disasterous zones, review of construction practices, implementation of I.S. Codes for designing and construction of earthquake resistant structures, interaction with research and industry etc. It may also include formation of a concerted earthquake dynamics control network.

The earthquake disaster mitigation involves the following four phases :

i) Pre-earthquake phase of preparedness
ii) Pre-cursory phenomena and occurence of earthquake
iii) Post-earthquake emergency
iv) Restoration, reconstruction and rehabilitation.

For effective earthquake disaster mitigation, the pre-earthquake phase needs to be utilised for planning and implementing preventive measures on the one hand and working out preparedness activities on the other hand. For achieving this, it may be useful to know the possible losses and damages an earthquake can bring, social problems created and emergency mitigative measures required. These are

- Landslides, rock falls, subsidence of ground fissuring, water ejection, etc. which cause blocking of tunnels, roads and rail-lines.
- Damage and collapse of houses resulting in dead and injured people and cattle, buried property, blocking of streets.
- Damage and collapse of bridges which impaires transportation of rail or road.
- Loss of hospitals causing dead and injured patients and reducing facilities for medical aid.
- Loss of schools causing death and injuries to pupils and teachers and loss of educational function
- Fire in homes and industries due to short circuiting of electric wires, kitchen fires, gas leaks etc.
- Collapse of water towers, damage to water pipes resulting in serious water supply problem
- Damage to communication facilities
- Dislocation of essential services security problem due to thefts and looting.
- Loss of overhead roof. This becomes even more acute if weather is cold and rainy or snowy.
- Decomposed uncared for bodies raise danger of epidemics
- Maintenance of law and order, protection of properties, keeping up the morale of the affected people
- Arranging reunion of separated families
- Rehabilitation of destitute persons, orphans, widows, the aged, and the handicapped etc. etc.

SEISMIC ZONING

Seismic zoning is the first and foremost requirement to serve the general purpose of distinguishing between the seismically active, less active and rather inactive areas. The zoning map published by the Bureau of Indian Standards in IS-1893, classifies five seismic zones based on experienced as well as expected probable intensities on 12 point MM intensity scale. A study of this zoning map shows that zone-V with probable intensities of IX and larger covers as area of 12%, zone IV with probable intensity, VIII covers 18% and Zone III with probable intensity VII covers 26% of our country's land area. In all these three zones covering a total area of 56% destruction and substantial damage to structures and system is probable. In Zone II based on intensity VI no collapse but only some minor damages particularly those of rural buildings is considered probable. Zone I is taken as of non-damaging seismicity. The distribution of density of population indicate that the total population threatened by the earthquake disaster is even higher than 56%. These figures give us sufficient warning on the potential of the earthquake hazard in our country, and the alarm is in view of the fact that majority of our structures particularly in the rural areas are non-engineered construction. It is to be noted that this zoning is not adequate to serve the special requirements of major structures such as dams, nuclear power plants, major industries etc. and major urban conglomerates for which a micro zoning based on local geological, geotechnical and seismological conditions is required. Such micro zoning will help in deciding on the land-use planning and proper selection of design factors for different types of structures. It may also be mentioned that the present zoning map is not adequate to describe the seismic risk adequately. It is necessary to develop the following maps to have a complete information.

i) peak ground acceleration maps based on return periods
ii) population distribution maps
iii) seismic risk maps taking into account of the soil conditions

In order to produce these maps the present seismological network needs to be improved and expanded and accelerograph arrays and spot locations increased alongwith instrumentation of all major structures.

EARTHQUAKE CODES, LAWS AND BYELAWS

For earthquake disaster reduction, the preventive approach of constructing all structures to be earthquake resistant in the first instance will be the most effective. For this approach, design and construction codes are basically needed. India has been in the forefront in this respect and formulated a general earthquake resistant design code IS:1893 in 1962 which has been updated lately in 1984. India was the first country to prepare an earethquake resistant building construction code IS:4326 in 1967, revised in 1976. Unfortunately, the implementation of these codes has very much lagged behind, as a result, stock of seismically unsafe buildings is expanding day by day. Even hospitals, schools and water supply structures which are of post-earthquake importance are being constructed without appropriate care in design and detailing. What is needed in the circumstances is the enactment of suitable legislation in the earthquake prone states and incorporation of the requirement of earthquake resisting features in buildings into the building-byelaws of the municipalities and corporations. To begin with this may be done in the states lying in seismic zones IV & V. Cost implications of code provisions on aseismic design for various types of building need to be studied. This is essential for implementation as well as rationalisation of IS Codes. It will also help in evolving better engineering solutions for earthquake protection to building. In fact it may turn out that the increase in cost of construction, to make buildings earthquake resistant, as compared to the overall cost of building, is insignificant provided proper choice of structural system has been made. Such a conclusion on the basis of a detailed and scientific study will definitely encourage, aseismic construction.

There is a very wide variation in actual construction practices in different parts of the country. In some seismic areas there is not much concern for seismic safety of structures and facilities while in other parts even the private builders are quite aware of the earthquake hazard even if not properly trained in aseismic construction.

Thus before the implementation of IS Codes can be ensured a document needs to be prepared on actual practices being followed particularly in the seismically active parts of the country. This will give a clear picture of reasons on why and where aseismic design practices are not being followed so that effort can be directed towards specific training and persuasion in such areas.

DAMS AND OTHER CRITICAL FACILITIES

Failure of a dam during an earthquake will add to the fury as the sudden release of the water contained in the reservoir causes flooding of the downstream areas inflicting heavy losses. Number of dams have been built in the country during different periods of time as per the engineering knowledge available at that time. It is necessary to evaluate the seismic safety of all such dams as per the latest state of art procedures of seismic design and analysis, and strengthen those structures wherever necessary. A programme of safety evaluation of the numerous existing dams in the country has already been taken up by the Dam Safety Organisations established in various states under the overall guidance of the National Committee on Dam Safety established by the Ministry of Water Resources. The dams which are taken up since the recent past are provided with a variety of instruments to monitor the behaviour of the structure over the years. Seismic instruments are also provided for dams located in the earthquake prone areas. Analysis of data obtained from these instruments not only provide us information on the performance of the dams but also help us in a way to verify the design procedures adopted and to modify them if required. Seismic monitoring around reservoirs before or after impounding yields valuable data and hence will have to be planned for all major reservoirs. Dam break analysis of preparation of inundation maps if the downstream areas may become very useful in the diaster preparedness planning for dam failure.

The International Congress on Large Dams (ICOLD) has issued guidelines for inspection of dams following earthquakes. Such inspections coupled with analysis of the instrumentation data are very useful in evaluating the seismic performance of the dam and take up strengthening measures wherever necessary to make it safe during any future events.

Similarly many other vulnerable facilities such as refineries and other chemical industries having a potential hazards of leakage and dissipation of piosonous gases, should be criticaly evaluated about their seismic safety.

EARTHQUAKE PREDICTION

Attempts have been made during the last two decades to use seismicity patterns as a tool for the prediction of earthquakes. But it is difficult to classify a seismic pattern uniquely and the identification of an impending earthquake is not very easy. In recent years, the P-wave residual methods has drawn the attention of many seismologists who tried to correlate the decrease in P-wave velocity with occurrence of many large magnitude earthquakes. Earthquakes owe their origin to complex geodynamic processes much of which is yet to be deciphered. The precursory changes taking place during this process are very minute and a global net work is needed to monitor surface deformations, displacements and strains by using space geodetic technique. Even the various data collected from the ground based stations needs to be processed. A thorough evaluation of these features may give a valuable clue to an impending earthquake disaster for adopting necessary anticipatory and precautionary measures. To develop these facilities large financial inputs and training of man-power are required, and it may therefore be realised that we have to go a long way before attaining a level of making reliable predictions of earthquakes in respect of time and magnitude.

EMERGENCY PREPAREDNESS AND CONTIGENCY PLANS

Emergency prepardeness should include hazard classification, public awareness, ensuring access and communications during emergency, establishment of warning systems etc. Emergency operations are aimed to prevent spreading of the disaster and further damages after the incident. This operation should cover every minute aspect of the life of the affected, and should start the moment the earthquake occured and to continue until minimum normalcy is restored. The problems usually faced after the occurence of an earthquake disaster are very vast and involves a number of administrative and technical aspects to be dealt with e.g. evacuation, shelter communications, health and first-aid. The management of disaster need involvement of various government departments as well as voluntary agencies who have to work together in a co-ordinated manner with men and materials mobilised at very short notice. Detailed contigency plans of action, with clear outline of responsibilities and authorities, need to be prepared and widely dissiminated for important engineering departments such as P.W.D., Water Supply and Sewerage, Electricity, P&T, Railway etc. to handle post earthquake situation without any loss of time in consultations, approvals, etc. Railways, for instance, have their well tested plan of action for the event of a railway accident wherein each one of its concerned employees knows what he is supposed to do. The fire fighting organizations also have streamlined action plans. This kind of experience even if for different contingencies, will be useful in preparing contingency plans for earthquake situation.

PUBLIC AWARENESS

Creating public awareness is a vital step towards loss minimisation. Random surveys carried out in some of the earthquake affected areas indicate that morethan 90% of the houses and other constructions particularly in the rural areas do not conform to the IS Codes or any other engineering standards. The public should be made aware of how to make their houses earthquake resistant and should be trained in about what emergency measures to be taken on the event of an earthquake. Audio-visual programmes, rural seminars, mock exercises should be included in such programmes. The voluntary organizations apart from the government agencies have an important role to play in this.

ROLE OF INSURANCE

The basic principle of insurance is to collect funds by changing small amounts of premium from large number of insuring public to meet the needs of unfortunate few. This insurance can play a major role in loss prevention and mitigation of impact of catastrophic earthquake by providing just and adequate compensation to the victims and in rebuilding of economy. By appropriate insurance pricing the public can be encouraged to construct earthquake resistant structures and to incorporate suitable loss prevention features for non-structural elements etc.

NATIONAL PROGRAMME FOR NATURAL DISASTER REDUCTION

Management of earthquake disasters like any other natural disaster calls for a multi-disciplinary effort and requires inputs by experts from the different fields.

Progressive strengthening of the nations' capacities to deal with natural disasters can be achieved only through such a connected effort. A start has already been made in this direction and valuable work on achieving the reduction of losses from natural disasters has been carried out, both at globle and national levels. The decade of ninties (1990-2000 AD) is proposed to be observed as an International Decade for Natural Disaster Reduction (IDNDR) under the aspecies of United Nations. As one of the many participating countries, India has already made a beginning. A National Symposium on preparedness, Mitigation and Management of Natural Disaster (PMMND) was organised by the Central Water Commission in August 1989 at New Delhi to serve as a curtain raiser and to help draw up a National Programme for the IDNDR. The symposium covered earthquakes alongwith other natural disasters like Floods, Cyclones and Windstorms, Avalanches and Landslides. Many useful and meaningful recommendations on the institutional arrangements and action plan required for preparedness, Mitigation and Management of Natural Disasters were made by this Symposium. One of the main recommendations is setting up of an Apex National Committee to spearhead the PMMND activities.

PHILOSOPOHY

Man always learns from his past experiences. History reveals that calamities, whenever they occured, have also provided some useful knowledge, which if properly analysed, could provide us with certain clues in dealing with such events. On the one hand, information gap should be reduced for a proper scientific and technical understanding of the nature's processes, and on the other hand, techniques to mitigate their effects should be developed to lessen the impacts of such potential events on the society.