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SEISMOLOGICAL NETWORK IN INDIA FOR RIVER VALLEY PROJECTS

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ABSTRACT

Regional and river valley networks of seismological stations maintained by the India Meteorological Department and other Institutions have been discussed. A brief summary of significant results obtained through the local networks around river valley projects has also been presented, for assessment of earthquake risk. Comparison of the seismicity during the pre-impounding period with that after filling up of the reservoir did not show any significant change so far around Pong and Pandoh Dams. However for monitoring such activity the observations need to be continued for a very long time.

INTRODUCTION

With the growing demand of harnessing our water resources for the the generation of electricity and flood control measures more and more dams are being constructed in the Himalayas and other seismically active regions in India. The need to provide a realistic and economic design seismic co-efficient requires comprehensive seismological data data input as the first requirement. Therefore, accurate monitoring of seismic activity is a prerequisite for assessment of earthquake risk. With this objective, the seismological network in the country is being increased and modernised for regional and local seismicity studies.

SEISMOLOGICAL NETWORK.

India Meteorological Department (I. M. D) is the official agency for monitoring of earthquakes and the study of related phenomenon. For this purpose, the department maintains a network of 36 permanent stations throughout the country. In addition, there are two cooperative observatories at Tocklai and Baroda (Fig 1)

Among the regional stations, the stations at Delhi, Shillong, Poona and Kodaikanal have been set up a part of World wide network maintained by the U. S. Geological Survey. The station at Shillong has been further up-graded to Seismic Research Observatory with a bore hole seismograph and parallel outputs in digital as well as analog form. The data from the regional stations is used not only to determine the epicentral parameters

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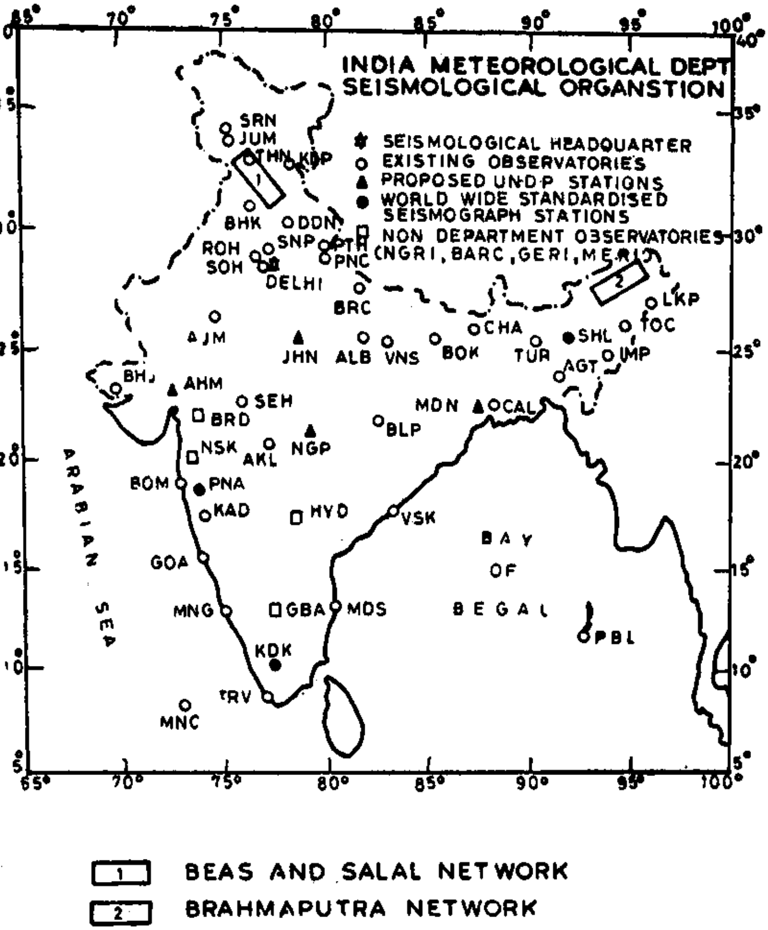

Fig. 1

but also to study their source mechanism for which world wide details needed. The data is also utilised to evolve velocity models in the crust and the mantle which are needed to determine the epicentral parameters of earthquakes.

IMD is also maintaining a network of 13 stations for Pong and Pandoh dams and Salal hydro-electric project. This network has provided excellent data to study the local tectonic features (Fig. 2) The Seismic activity is continuing in the zone of the great Kangra eartquake of 1905 while towards east of this region lies the 'seismic gap' where an earthquake upto magnitude 7.5 may be expected (Srivastava atal 1984) The results have also

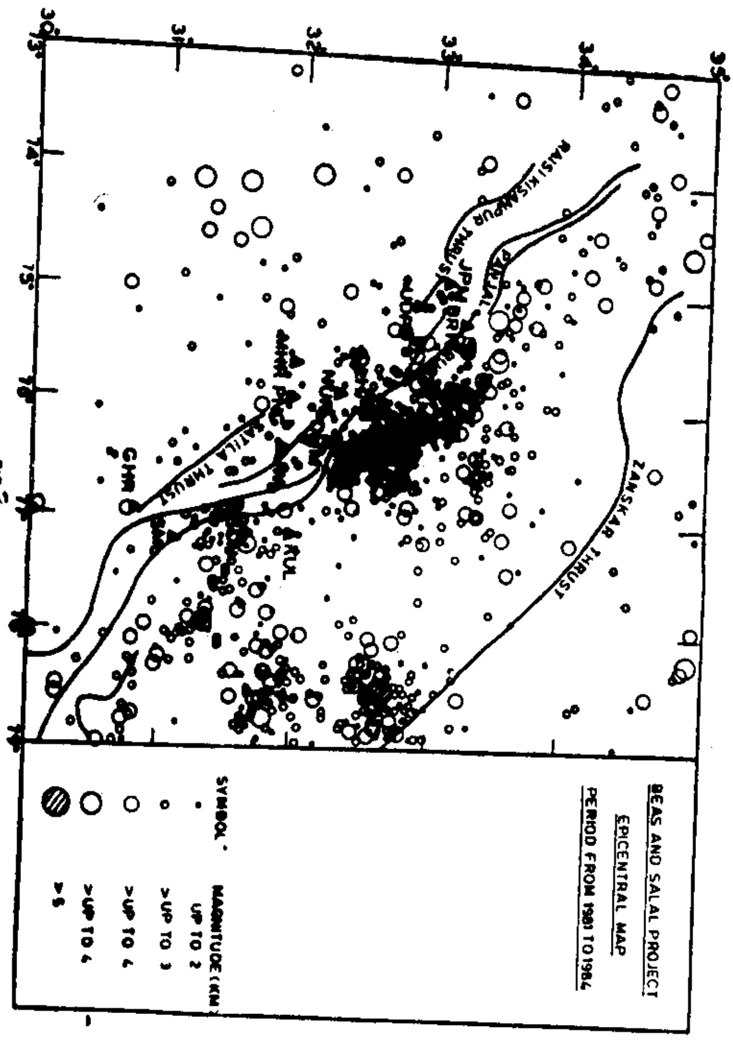

Fig. 2

shown that there is no significant increase in earthquakes of magnitude 3.0 or more around Pong and Pondah dams after impounding the dams (Srivastava and Dube, 1982). In this region, 50 accelerographs have been installed by the department of Earthquake Engineering. Also similar array is being installed in northeast India. IMD is also opening five stations around the proposed Chandil Dam Projects. A few more seismological stations maintained by other organisations in the country are given below.

(a) National Geophysical Research Institute (NGRI), Hyderabad and Regional Research Laboratory (RRL), Jorhat.

Under a collaborative programme between NGRI and Regional Research Laboratory, Jorhat new seismological stations were installed at Jorhat, Kohima, Khonsa and Yaongyinisen, Itanagar and Kaziranga. This has enabled to reduce the detection threshold for earthquakes in the region to magnitude 3.5 when the data from IMD stations is included. On an average 30 to 40 earthquakes are located every month pointing out the active seismicity of the region.

In addition to maintenance of the observatory at Hyderabad, NGRI is also running two seismological stations close to Nagarjun Sagar and Srisailam dams

(b) Universities of Roorkee and Kurukshetra

A wide band wide dynamic range feedback seismograph system which is the first of its kind in the country was established at the Department of Earth Sciences, University of Roorkee in first week of October 1982. The system was donated by Alexander Von Humboldt Foundation, Bonn, F.R. Germany through the support extended by Prof. B,J, Duda, Institute of Geophsics, Hamburg University, The seismological station at Kurukshetra also continued to function well.

(c) Bhabha Atomic Researc Centre

The seismological Array station established since 1965 at Gauribidanur has contributed significantly for understanding the seismicity of the peninsular India and other seismological problems.

(d) Idduki Project

A fairly good and uniform distribution of seismic stations is maintained at the Idukki dam. Idduki, Kulamavu and Aladi form a triangular network of three stations around the reservoir. Other three stations at Meencut, Pallin and Pamba are located relatively far off from the reservoir.

(e) Tehri network (Uttar Pradesh)

Seismological stations at Tehri, Narendranagar, Rudraprayag and Kishau assess the Seismic activity in the region.

(f) Gjrarat network.

Seismological stations are being maintained at Chattarpur, Sajeli, Arthuna, Bakor, Kavadia and Ukai by the Gujrat Engineering Research Institute, Vadodara.

(g) Koyna and Bhatsa network (Mahrashtra)

A network of ten seismological stations in Koyna region and 8 stations in Bhatsa region are being maintained by Maharastra Engineering Research Institute, Nasik.

INSTRUMENTAL DEVELOPMENT

A number of instruments used in seismological observatories were made in I.M.D. These included Wood Anderson type Torsion Seismometers, Short Period Electromagnetic seismometers (both vertical and horizontal components), photographic and visible recorders and precision time marking clocks. The accelerographs RESA V are being manufactured at Roorkee University.

In view of the need for development of indigenous seismographs for micro-earthquake monitoring, the Central Scientific Instruments Organisation, Chandigarh has fabricated a set of analogue and digital systems. These have yet to be tested in the field.

EXCHANGE OF DATA

The data from the permanent seismological stations in the country is compiled into event data sheets and monthly seismological bulletins. These are supplied to a large number of interested Institutions in India and abroad The data from I.M.D. along with that from BARC, NGRI and Kurukshetra University is included in the bulletins of International Seismological Centre, U. K. In addition, the international exchange of of daily data from the WWNSS stations is continued with the National Earthquake Information Centre, Boulder, Colorado. Marksense cards were also supplied to the ISC.

LOCAL NETWORK DESIGN.

The accuracy of hypocentral determination depends upon the geometry of seismological stations.

P-wave arrival times at Beas Project seismological stations were obtained by Monte Carlo method for 200 sets of simulated earthquke occurrence at each grid point at 0.5° interval in this area assuming the observational error to be normally distributed with mean zero and standard set were determined by HYPO 71 program. The errors in hypocentral parameters (location, focal depth and origin time) were determined by finding the mean of the differences of computed values from actual values. Contour lines of these errors and their standard deviations were shown in and around the Beas project network. It has been found that at a grid point away from network where azimuthal gap in the seismological stations is more than 315°, the observational error (assumed above) gives rise to an error in origin time greater than 5 sec. (on the positive side i.e. ahead of actual time). shifts the focal depth deeper by more than 5 Km. However, close to network in the vicinity of Pong and Pandoh Dams (with azimuthal gap less than 3150)the errors reduce further (Bhattacharya et al, 1982). Similarly in north east India, India Meteorological departmet is maintaining 12 seismological stations and other organisations are also running 8 stations. Pwave arrival times from 200 earthquakes at each grid point are simulated by Monte Carlo method assuming the error in arrival time is normally distributed with mean zero and standard deviation 0.1 sec. The hypocentre and origin time of each simulated earthquake are determined by HYPO 71 programme. The error and their standard deviations in epicentral location and origin time are estimated by finding the means and standard deviation of the differences of computed values and actual values at each grid point. Contour lines of these errors and their standard diviations are drawn. It is found that error is origin time determination is within 0.1 sec. which is also the standard deviation of error in P-wave arrival time observations. The standard deviation of this error in origin time remains within 0.2 sec. In major part of the region the error in epicentral detemination is within 2 Km with standard deviation of 1 Km. The determined epicentre which are away from the network tend towards the network from the actual location. (Bhattacharya etal, 1985)

MICROEARTHQUAKE SURVEYS

The development of high gain portable seismographs enable us to detect microearthquakes to delineate the fault and the mechanism of local earthquakes during the pre design stage.

I, M. D. has conducted several micro-earthquake surveys in different parts of the country It deployed a set of high gain seismographs in India and Nepal for monitoring aftershocks activity after the damaging earthquake of July 29, 1980 near India Nepal Border. Seismic monitoring was also done in Srisailam dam region through a set of 5 portable high gain seismographs. Under Crumonsonata project of Geological Survey of India, micro-earthquake Survey was undertaken across Narbada basin during 1980-81, 1981-82 and 1984-85 D. S. S. FIELD Seasons. Microearthquake survey around Thein Dam has thrown light on the activity of lineaments in the region (Bhat acharya et al 1986)

With a view to assess geothermal Potential in relation to micro-earthquake activity 5 portable seismographs were deployed in Ladakh region jointly with the Department of Eearthquake Engineering, Roorkee. A set of eight high gain microearthquake seismographs well distributed in azimuth were operated for about 2½ months in Manikaran region of Himachal Pradesh. Accurate locations of micro-earthquakes have brought to light interesting features of the seismic activity in the region. Short term micro-earthquake observations have been taken up by the Department of Earth Sciences, Roorkee in Kumaun Garhwal region of Uttar Pradesh. In the Assam region, surveys were conducted in collaboration with the Geological Survey of India. Interesting results pertaining to the mechanism of earthquakes have been reported.

India Metrological Department participated in the Deep Seismic Sounding programme of National geophysical Research Institute. Five to six stations are being operated by the India Metrological Department in each field season along the profile to record the DSS explosions with a view to obtain averaged crustal structure in region which is needed for improving the location of microearthquakhs.

NEW CATALOGUE OF EARTHQUAKES

Based upon the recommendations of the UNESCO experts after the Koyna earthquake of December, 1967, a new catalogue of earthquakes for peninsular India has been prepared for the period 1839-1900. The data has been extracted from the micro-films of The Times of India, Statesman and The Hindu for the period commencing with their publication(1839) to the installation of seismological instruments in the country (1900). It is interesting to note that the region where significant erthquakes have occured, tremors of felt intensity have been reported several years preceding the main events. (Srivastava and Ramachandran 1984). Another catalogue of earrhquake whfch is widely used for assessment of earthquake risk was published in Jai Krishna Volnme (Tandon and Srivastava, 1974) This is now available as a magnetic tape file in I M.D.

FUTURE PROGRAMMES.

According to the recommendations of the Planning commission during 1972, the network of permanent seismological stations should be increased to 103. This is being achieved in a phased manner. Under the D.S.T. sponsored project entitled "Study of Seismicity and Seismo-Tectonics of Himalayan Re6ion", a network of 18 stations has been proposed out of which one station has started functioning at Allahabad. Under a UNDP collaboration Project, 4 new stations equipped with digital seismographs will be installed in peninsular India near Narbada rift. Two multi-channel telemetered Arrays have been proposed around Delhi and Shillong (in addition to one array being procured by the Roorkee University) which will enable us to monitor space and time variations of seismic activity around these regions.

In order to improve accuracy in the epicentral determination, programe has ben undertaken jointly by National Geophysical Research Institute, Space Applications Centre and India Meteorological Department which will enable us to receive the digitised seismological data through INSAT at a Central recording station with arrangements for a common time base so that epicentral determination can be uudertaken on semi-real time basis. Initially the pilot project will be restricted to the stations in north-east India Tne seismological network in northeast India is being further augmented through NGRI/NEC/RRL Programme and under D.S.T project on Himalayan seismicity.

Under another programme sponsored through the Department of Science and Technolology for integrated studies in the Bay of Bengal, seven new seismological stations will be opened to monitor the seismic activity in the region It is expected that by the end of seventh Plan, about 80 stations of proposed 103 permanent stations will be in operation in the country.

It is suggested that while finalising the design seismic coefficients through the standing committee set up by the Ministry of Irrigation for important projects, we should recommend a network of seismological stations so that changes in the design on the basis of of seismic activity monitored may be incorporated as and when needed in addition to effects of filling of the reservoir,

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