15 Aug 2008, 1:30 pm - 3:00 pm

Monitoring Seismic and Geophysical Paprameters With the Help of College Instruments and Staff

Arun Bapat

Consulting Seismologist, Kothrud, Pune, India


6th International Conference on
Case Histories in Geotechnical Engineering, Arlington, VA, August 11-16, 2008

MONITORING SEISMIC AND GEOPHYSICAL PAPRAMETERS WITH THE HELP OF COLLEGE INSTRUMENTS AND STAFF

Arun Bapat
Consulting Seismologist
1/11, Tara Residency,
20/2, Kothrud
Pune – 411038 (India)
arun_bapat@vsnl.com

ABSTRACT

A number of geophysical and seismically significantly related parameters are routinely measured in college laboratories. These are Magnetic field, Gravity field, Radioactivity, sub-surface temperature. After one major earthquake in India (M = 6.5, Latur earthquake of 29 September 1993) some colleges were used to measure these parameters. These parameters show premonitory changes prior to the occurrence of main shock. As the experiment was undertaken during post-seismic period the magnitudes of the seismic events were in the range of 4.5 to 5.0. The advantage of such method is that these are extended over an extensive area.

INTRODUCTION

The seismic hazard and its mitigation are increasingly becoming important not only from social and economic point of view but also from scientific and engineering point of view. The developing countries have increased the number of large structures such as industrial units, power generation, dams, airports, ports and harbor, roads and communication etc. All these structures need to be protected from various natural disasters. Earthquake is one of the natural hazard feared most as it occurs with almost little warning and few seconds vibrations cause heavy damage to all structures. There has been very good and appreciable progress in the field of earthquake engineering during last few decades. The seismically active regions and faults have been heavily instrumented to monitor the geo-stress, movements and other seismological, geological, geophysical, geodetic parameters. These measurements have been found to be quite useful. But these parametric measurements are mostly used and are accessible to the concerned engineers and scientists and at times administrators. Common man finds it difficult to get these readings. As earthquake is a pervasive phenomenon, it is though that monitoring and understanding the associated seismic process by common man would help in mitigating efforts.

THE LATUR EARTHQUAKE

A Magnitude 6.3 earthquake occurred at Latur on 29 September 1993. The epicenter was located at 18.01 N and 76.56 E. Though the magnitude of the earthquake was moderate it took a death toll of about ten thousand lives. One of the reasons was the origin time was 04 05 hrs (Local Times) and most of the houses were made of stone and mud. The author undertook the Macro seismic survey of the earthquake. During the field survey it was seen that there were a number of seismic precursors observed by common man. The most commonly observed was the abnormal behavior. Bapat (2003,2005) has discussed the seismic precursors observed prior to this earthquake.

THE SELECTION OF PARAMETERS

It was seen that several people observed some precursory seismic parameters. However, these parameters such as abnormal behavior are at present, not accepted by scientific community. Rikitake (1982) had discussed extensively about several seismic precursors. The availability of scientifically acceptable scientific parameter was urgently examined and the following four parameters were identified. (a) Magnetic field (b) Gravity field (c) Radioactivity and (d) Sub-Surface temperature. These parameters are useful from seismic precursory point of view and are routinely measured in several colleges. The students perform experiments in college laboratory as part of learning. Students for passing examination routinely undertake these exercises.

As a part of post seismic disaster mitigation and creating awareness amongst the common people it was decided that

the experimental work being undertaken by students in schools and colleges would used for seismic monitoring.

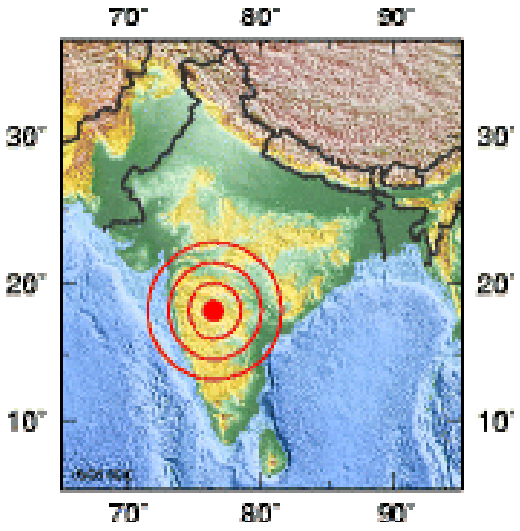

Fig.1 The epicenter of Latur earthquake of 29 September 1993

EXPERIMENTAL DETAILS

The epicenter of the earthquake lies in the State of Maharashtra and Mumbai (formerly Bombay) is the Capital of the state. Seven Administrative units known as District were chosen for observation. These are (1) Aurangabad (2) Osmanabad (3) Nanded (4) Parbhani (5) Latur (6) Jalna. The total area covered by these districts is about 80.000 sq. km. From each district two colleges were selected. The selection of colleges was made in such a way that the minimum and maximum distance between two measuring points was in the range 30 to 50 km. As such there were total 14 measuring points. From each college two staff members were selected and they were given suitable training with the introductory ideas and practices in seismology. They were told about the significance of the measurements.

Teachers were told to take readings once a week for gravity, magnetic and radioactivity. At a tome three readings were taken and the average value was recorded. For these measurements magnetometers, gravity pendulum and Geiger Muller Counter (for Radioactivity), which are regularly used in college laboratories, were used. For the measurement of sub-surface temperatures a pit of 1.0 sq. mt cross section with a depth of 2.0 m is required. The pit has to be in a covered place and should not be exposed to atmosphere. A mercury or bi-metallic thermometer was placed at the bottom of the pit and temperatures were measured at 0900 and 1600 hrs daily. The daily temperature readings were used to calculate the average weekly and monthly temperatures. The readings were systematically taken and at the end of the month were sent to the central office for further analysis.

ANALYSES OF OBSERVATIONS

As the experiment was performed during the post seismic period, there were only aftershocks with the maximum magnitude of 4.5 on Richter scale. This has set a limit to the measurement. It is well known. It is well known that prior to the occurrence of a moderate to large earthquake, the geomagnetic field is reduced. This adversely affects the reception of electromagnetic waves in the epicentral area. As a result the reception of radio and television signals is adversely affected about 20 to 30 hours. The reduction in the geomagnetic field is a result of rise in temperature at depth in the epicentral volume. Bapat (2003) has explained this with a mathematical formula.

$$(f) = 1/ 2\pi \text{ sq. rt } (LC)$$

Where f is the transmitted frequency, C is the capacity of the capacitor; L is inductance and 2 and π are constants. When the subsurface temperature rises the magnetism is reduced and hence the reception frequency rises.

Similarly, depending upon the type of earthquake mechanism there could rise or decrease in the gravity. The pendulum measurement has a very good accuracy. A telescope measures the length of the pendulum to the accuracy of 0.5 mm. The average value of gravity is 9.88 meters / s/s. These figures give very good accuracy.

During the pre-seismic period a number of micro-fractures occur. As a result more radioactive gas such as radon comes out and there is rise in radioactivity. This experiment was conducted for a period of one year. It was observed that the sub surface temperatures were above the normal values by + 2° to + 4° C. This was seen about 40 to 60 hours before the occurrence of earthquake.

There were no appreciable changes in radioactivity.

It was seen that the reception frequency on communication band of 5000 kHz was increasing by a value of 35 to 70 kHz about 15 to 20 hours before the occurrence of earthquake of magnitude in the range 4.0 to 4.5. These experiments were found to be useful. It is planned to extend similar observations to other regions.

ADVANTAGES AND DISADVANTAGES OF THE METHOD

The method has several advantages. (a) It is cheap and could be started without any financial provisions. (b) It does not need any new instruments or personnel. (c) As the number of reading points are large, errors if any is reduced

in averaging. (d) The detection potential of the instrument is high due to dense location. (e) It gives a sense of participation amongst the college students and staff.

It is possible that the measurement could suffer from (a) instrumental error (b) personal error (c) it ha less accuracy. Keeping these advantages and defects of the measurements, it could decided that if at any location the measurements show a change or deviating trend in the readings, specialized instruments could be deployed for precise measurements. These measurements could be started with a short notice and one day training to the staff. The accuracy of measurements will not be hundred percent correct. It could be in the range of 90 % to 95% .In locations where there are no instruments; it is better to have 90 % correct reading than having no readings.

CONCLUSIONS

Seismological instruments regularly undertake monitoring of seismic activity. But it has some limitations. It is difficult to have dense seismic network. In order to have more useful data for surveillance seismic monitoring could be supplemented by measurements in colleges.

REFERENCES

Bapat, A. (2006). Seismo-Electro-Magnetic and other Precursory Observations from Recent Earthquakes, Proc. First India Disaster Management Conference, New Delhi

Bapat, Arun (2003). Role of Telecom in Seismic Surveillance, National Sym. Development in. Geophysical Sciences in India, Varanasi (India) pp 129 – 132.

Rikitake, T. (1982) Earthquake Forecasting and Warning. D. Riedel Pub. Co Dordrecht, Boston, London