BOOK REVIEW

A COMPREHENSIVE SURVEY OF THE 26TH JANUARY EARTHQUAKE (Mw 7.7) IN THE STATE OF GUJARAT, INDIA by Tamao Sato and others. Report published by the Japanese Ministry of Education, Culture, Sports, Science and Technology, 2001, 117p.

This report encompasses findings of a research team consisting of several researchers from universities in Japan under the leadership of Prof. Tamao Sato of Hirosaki University. The visiting team of Japanese scientists was provided support by Indian scientists from Indian Institute of Technology, Kanpur, Indian Institute of Geomagnetism, Mumbai and University of Roorkee, Roorkee.

Basically, the survey was conducted under the following four topics:

1. Search for surface faults associated with the earthquake.
2. Aftershock observations.
3. GPS monitoring of post-seismic deformation.
4. Evaluation of casualties and damage to buildings and lifelines.

The report consists of eight chapters. In the first chapter on Tectonic Setting, Tamao Sato provides a broad tectonic framework of the Bhuj area. A list of the earthquakes that occurred in the vicinity of Bhuj earthquake during the last 300 years is provided. The revised focal parameters of earthquakes are given. The next chapter deals with Surface Deformation and Active Faults. In an interesting paper by Nakata et al. several profiles depicting the ground deformation and photographs demonstrating upheavals are shown. A number of trenches were dug and deformation in the upper few metres of the soil has been mapped. Investigating active faults in the region Malik et al. note that the work carried over the last 4-5 years suggests an on-going tectonic activity in the region. However, no effort was made to identify active faults and work-out the repeat time of major earthquakes. The active faults identified by the authors are likely to provide information about the sites where palaeo-seismological investigations need to be carried out to investigate earlier earthquakes.

The third chapter deals with Aftershocks and Slip Distribution of Mainshock and has two papers by Negishi et al. on aftershocks and by Mori on slip distribution. Negishi et al. installed a temporary array of seismographs and operated it for six days from 28 February to 6 March, 2001 and located 1400 aftershocks. They have compared the results with the Taiwan earthquake of 1999 and have drawn attention to the fact that the Bhuj earthquake ruptured a smaller fault area and the slip distribution was simpler. Mori identified a large initial pulse from tele-seismic records and suggest that this pulse was responsible for the ground velocities and displacements in the epicentral region. On the basis of these observations, they have interpreted a plane that dips towards the south at 45° to be the fault plane. The aftershocks are distributed within a focal depth of 10 to 35 km and they do not appear to extend to the surface. The aftershocks are constrained to an area of 40 x 40 km^2 which is small for a Mw 7.7 earthquake and indicates a high stress drop of 12 to 24 Mpa.

The fourth chapter is dedicated to Post-seismic Crustal Deformation deduced from GPS observations. Under this chapter Miyashita et al. report that post-seismic crustal deformation has been inferred from two campaigns of GPS network observations. They are not in a position to detect post-seismic crustal deformation associated with the 2001 Bhuj earthquake. However, the changes in the vertical component are larger than those of north-south and east-west components.

The fifth chapter deals with the Outline of Damage Survey by Murakami, where he has reported the statistics of lives lost, injured people, missing people and damage to the buildings, classified among pucca, kachha and huts. According to Government of India, a total of 20,005 human lives were lost, 166,000 people were injured (20,717 injured seriously) and around 250 people were missing. Damage by the earthquake was immense and about 187,000 pucca houses were completely destroyed. Whereas the number of kachha houses and huts destroyed is much more.

Chapter six deals with the Estimation of Macroseismic Intensity. Under this chapter there are three papers. The first paper by Hisada and Meguro deals with macroseismic intensity deduced from building damage. MSK Intensity Contours are drawn based on the damage to type-I, type-II and type-III buildings. Finally, they have drawn a contour map using all data. They have compared their map with the intensity prepared by Narula and Chaubey (2001) and they find significant differences. The map by Narula and Chaubey

(2001) locates Bhachau out of intensity X area and Raper inside it. The map prepared by Hisada and Meguro is just opposite. They have given reasons for these differences, and their intensity map looks more authentic. Murakami and Katta have prepared the MSK intensity map using the questionnaire which they distributed to a large number of people. The intensity map thus obtained is in close agreement with the intensity map prepared by Hisada and Meguro. The third paper in this chapter deals with Ground Condition Estimated from Microtremor Observations by Sawada et al. In this paper, Sawada et al. used recording of micro tremor in several cities to estimate the ground conditions. One of the major findings of their study is that the damage observed at Ahmedabad is attributed to site affects due to ground structure around Ahmedabad. They have drawn a similarity in damage in Ahmedabad with the damage in Mexico City by Michoacan earthquake of 1995. They have made an important observation that detailed survey of ground characteristics is necessary to characterize locale specific ground structures that affect the ground motion during an earthquake.

The seventh chapter on Building Damage has four papers. The first paper by Kono and Tanaka deals with damage of reinforced concrete structures. They observed that during this earthquake many reinforced concrete structures suffered from minor to catastrophic damage. Since buildings having sound structure, should not have experienced major damage, the damage could be due to inadequate detailing, poor quality of material used and unsound construction practices. Hayashi et al. have investigated damage in Ghandhidham. The authors observed that the town of Ghandhidham was built from 1950 onwards. It was affected by the Anjar earthquake of 1956 and subsequently houses were built to withstand earthquakes. This retrofitting after the 1956 earthquake helped and houses in Ghandhidham were not much affected. This supports the concept of strengthening the buildings after a fresh earthquake so that it behaves better against the future earthquakes. Meguro et al. have investigated Damage to Masonry Structures. In this very detailed paper, an in-depth study is made of the lives lost and casualties. The authors find that most of the casualties were because of collapse of poorly constructed structures. They classified masonry construction according to construction material and construction type. The large damage is attributed to weak bond of masonry wall, weak beam-column joints etc. The authors point out that several structures performed much better primarily because of good workmanship and proper care during the construction.

In the last paper in this chapter, Pareek et al. deal with building material, repair and strengthening methods of earthquake damaged RC structures. The authors conclude that there was a great variation in the quality of building material used which vary from good quality to poor quality. In some buildings, the poor quality of material used was responsible for the collapse of the buildings. In some buildings, the material used was of good quality, however, the detailing and the structural design was poor causing the damage. One of the major findings is that for most RC buildings the "soft first storey" situation has to be removed. The authors recommend preparing repair manuals which should be distributed to local contractors for strengthening the buildings.

The last chapter deals with the Damage to Civil Structures and Liquefaction by Hamada et al. After a very detailed survey, the authors conclude that widespread liquefaction was observed in Rann of Kutchch, the little Rann of Kutchch, coastal areas and in the vicinity of Gandhidham, Kandala and between Malya and Samakhiali. As anticipated, liquefaction was widespread alongside sea shore, river beds, ponds and marshy lands. Most of the dams are earthen dams and their failure was due to the liquefaction of sub-soil along the old river course. The roadways have to be re-surfaced due to extensional and bulging type of cracking. The railway bridges were not damaged. The structural damage to Kandla and Naralakhi ports was minor. The well constructed Kakrapar nuclear power plant, located at a distance of 400 km southwest, was operational at the time of earthquake and suffered no damage.

The visiting team of scientists and engineers from Japan along with support from Indian counterparts have prepared a survey report on 26 January 2001, Bhuj earthquake. Many observations reported are available elsewhere in newspapers and magazines also. However, the best part of this report is on the engineering side, particularly estimation of macro-seismic intensity and building damage. I expected such a report to have an executive summary, so that a reader could have quick overview. I recommend that this report be perused by all engineers and earth scientists for a better understanding of the Republic Day Bhuj earthquake of 2001 and its effects. The authors need to be complemented for making a very factual report available in a short time.

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