MACROSEISMIC STUDIES OF SOME RECENT INDIAN EARTHQUAKES

by

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SYNOPSIS

During the period 1968 - 1970 four medium sized earthquakes occurred in India - three in the peripheral portions of Peninsular Shield and the fourth in the Nagaland region of the Extra Peninsular area. Study of these four recent Indian Earthquakes through extensive field surveys and questionnaire programme has revealed that local foundation conditions and regional geology play a major roll in deciding the nature and extent of damages to surface structures. Decrease of seismic intensity with depth has also been observed. A brief description of surface damages observed and discussion of their main features have been given.

Koyna (Maharashtra) Earthquake of Oct.29, 1968 (1000 hrs.GMT)

Pophali (Koyna area) and adjacent terrain was rocked by an earthquake of Richter Magnitude 5.2 (maximum recorded ground acceleration at epicentre = 16% of 'g') on October 29, 1968. No serious damages to life and property were reported nevertheless the shock provided an excellent opportunity for studying influence of local foundation conditions on the nature and extent of damages to surface structures. Figure 1 shows isoseismals VI and V (MM) of this earthquake. From the analyses of seismograms of a few selected local tremors equidistant from each of the four identical electromagnetic seismographs working in the Koyna seismograph net it could be inferred that the recorded amplitude of ground motion is governed by the nature of local foundation material and is amplified about twice and four times on literitic and alluvial foundations respectively when compared to basaltic foundations(1). Nature and extent of damages to structures in the present earthquake have corroborated these observations. Fall of seismic intensity with depth was also in evidence in the Pophali Hydel Power Station situated about 250 metres below the surface where a decrease in intensity observed was at least one unit less in MM Scale (VI to V).

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Kothagudem (Andhra Pradesh) Earthquake of April 13, 1969 (1525 hrs. GMT)

On April 13, 1969 occurred an earthquake shock of Richter Magnitude 6 with its epicentre in the Godavari Valley and was felt widely over south central India (2). No serious loss of life and damages to property were reported. Fig.2 shows isoseismals VI and V (MM) and effect of regional geology on the distribution of intensities.

Local heavy damages to surface structures along the banks of the river Godavari and its tributories and streams in the valley, such as at Parnasala, could be attributed to thick pile of unconsolidated and moist sediments underneath (3). Ground fissures were developed at a few places in the apparently dry beds of streams through which water gushed out. 30 metre high Kinnarsani composit dam which was very close to the epicentral tract developed minor cracks in the earthen portions where it has been keyed to the hillock. Generators in the thermal power stations at New Paloncha and Ramagundam tripped due to severe shaking. No damage, however, of significance was caused to well designed and soundly founded tall R.C.C. structures such as cooling towers, boiler chimneys and overhead water reservoirs in the locality. Residential buildings in this area built in brick and cement and founded mostly on disintigrated rock developed extensive cracks.

Influence of regional geology on the degree of damages to structures was in evidence all over the area. Decrease of intensity at least by one unit in MM Scale (from VI to V or IV) could be observed while crossing over the boundary between less elastic sedimentary formations to highly elastic crystalline rocks. Fall of seismic intensity with depth could also be observed in Singareni group of collieries at Yellandlapad where miners could hardly sense shaking in the underground while damages to surface structures in the same locality were quite significant (I = VI).

Broach (Gujrat) Earthquake of March 23, 1970 (0153 hrs. GMT)

An earthquake shock of Richter Magnitude 6.7 severely rocked the old town of Broach and adjacent villages in South Gujrat on the morning of March 23, 1970 taking a toll of 26 lives and injuring over 100 persons. From the survey of damages an intensity of VII in MM scale could be assigned in the epicentral area. Macroseismic survey of the affected area revealed that the extensive damages were mainly confined to the northern bank of the river Narmada where the bed rock suddenly attains large depths in contrast with medium to slight damages on the southern bank where the bed rock is comparatively shallow. Major ground fissure running close to the southern bank and mostly confined to the flood plains consisting of unconsolidated river sands and clays was not the site of maximum damage

and its occurrence could perhaps be attributed to sudden change in bed rock topography across the river. Cold and muddy water spouted through the crack at several places after the quake showing that the crack was not deep. Residential buildings in Broach town situated in localities where the underlying soil was moist and slumpy suffered heavy damages while structures resting on comparatively hard and dry soil in the same area escaped with only moderate to slight damages. Two anchor bolts of the base plate on the second pier from north end of the major broad gauge steel railway bridge across the river Narmada near Broach sheared off. Four storeyed 64 year old Municipal clock tower in Broach town developed a horizontal crack and the upper storey was twisted through about 1.5°. Several cases of shifting and tilting of objects such as heavy textile machinery in a local mills in Broach were observed. Figure 3 shows microzoning in Broach town and figure 4 shows isoseismals VII and VI.

Nagaland (Assam) Earthquake of July 29, 1970 (1016 hrs. GMT)

Influence of regional geology and effect of thick pile of unconsolidated sediments on the distribution of earthquake intensities could be markedly observed in the area affected by the Nagaland earthquake of July 29, 1970. This earthquake of Richter Magnitude 6.4 could be classified as a shock of moderate size and yet a fairly large area in the North Eastern Corner of India was affected by it. From over 200 questionnaires received and other data collected from the affected region maximum intensity of VI in MM Scale could generally be assigned in the epicentral tract though local enhancement in the intensity upto VII, such as a-t Digboi, Margherita and Imphal, could be ascribed to extensively fractured rock formations and thick pile of local sediments. The epicentral tract runs parallel to Haflang-Disang thrust fault(4) which trends NE-SW in upper Assam and perhaps indicates that the earthquake owed it origin to tectonic adjustments along the fault. Figure 5 gives isoseismal map.

References :

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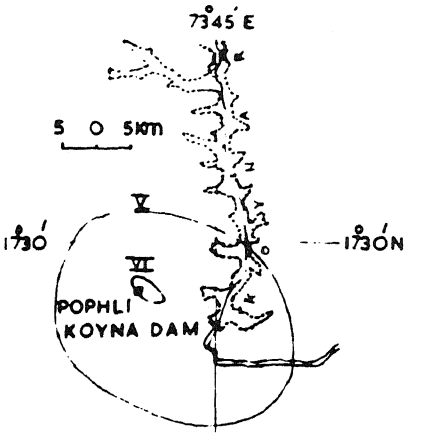

FIG.1. ISOSEISMAL MAP OF KOYNAGAR EARTHQUAKE OF OCTOBER 29,1968.

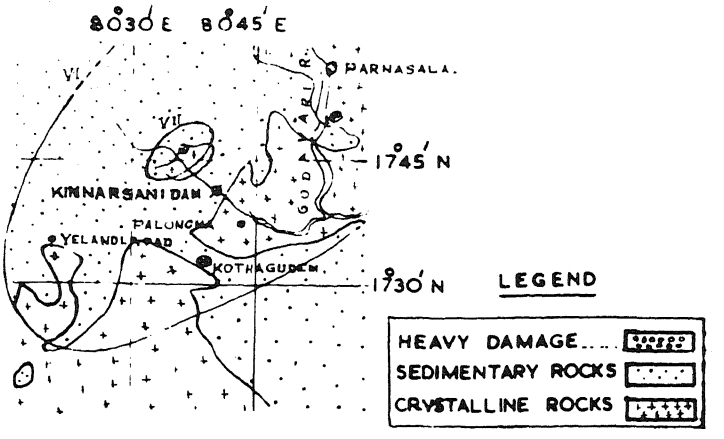

FIG. 2. ISOSEISMAL MAP OF KOTHAGUDEM EARTHQUAKE OF APRIL 13, 1969.

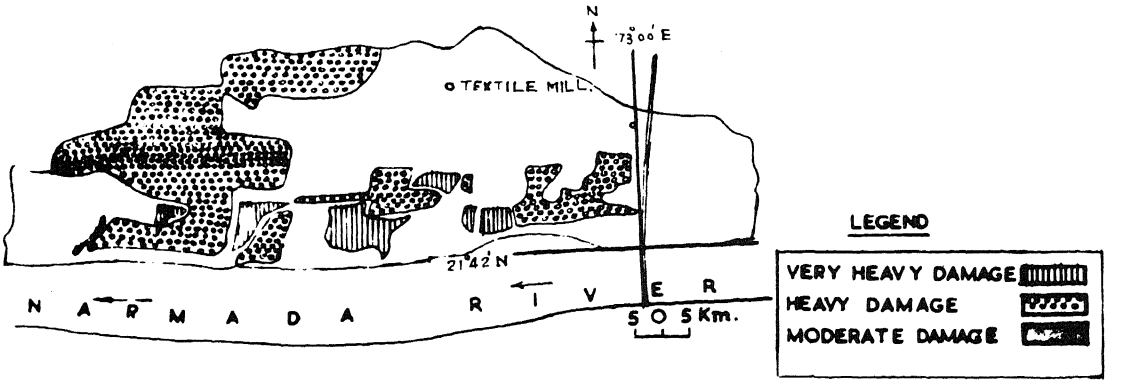

FIG.3. BROACH TOWN PLAN SHOWING DAMAGE TO VARIOUS LOCALITIES DURING MARCH 23,1970 BORACH EARTHQUAKE.

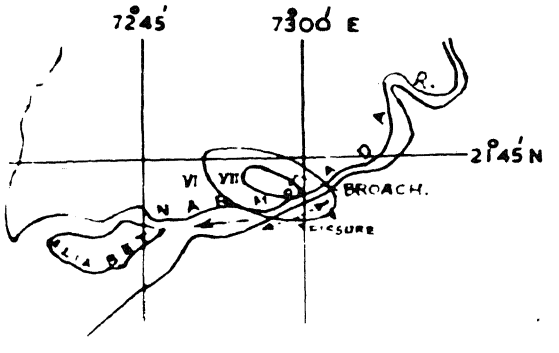

FIG. 4. ISOSEISMAL MAP OF BROACH EARTHQUAKE OF MARCH 23, 1970

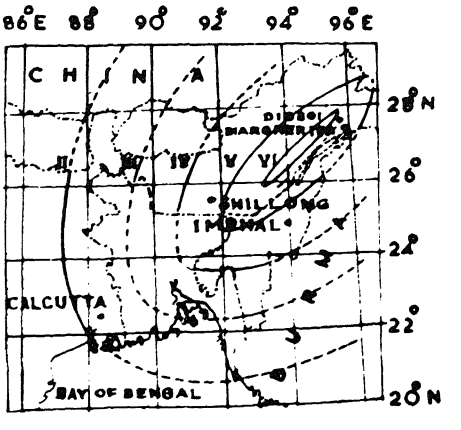

FIG. 5. ISOSEISMAL MAP OF NAGALAND EARTHQUAKE OF JULY 29,1970