Bull. Ind. Soc. Earthq. Tech. Paper No. 290, Vol.27, No.3, Sept. 1990, pp.59-63

PRELIMINARY ISOSEISMAL MAP OF BIHAR-NEPAL EARTHQUAKE OF AUGUST 21, 1988

By

Brijesh Kumar
Department of Earthquake Engineering,
University of Roorkee, Roorkee - 247 667

ABSTRACT

On the basis of the information on earthquake occurrence collected through questionnaires on damage survey, isoseismals VI to VIII on Modified Mercalli scale have been drawn and compound with the intensity based on spectral accelerations. Maximum intensity VII+ was observed at Sharan, Dhankuta, Tehrathum, Udaypur and Ilam in Nepal and at Jogbani in Bihar. Dharan Distt. was the most affected region in Nepal where about 90% buildings were damaged. The intensity VIII was observed in and around Darbhanga district where all Kutchcha houses were severely damaged, many of them almost collapsed, and cracks developed in ground and many retaining walls. The elliptical shape of the isoseismals with its major axis having NE-SW trend coincides with general structural trend of the area. Records of Structural Response recorders (SRRs) support the views of general public, particularly in and around Darbhanga town.

INTRODUCTION

The Eastern region (Bihar-Nepal) of India was rocked by a severe earthquake of magnitude 6.6 on Aug. 21,1988. It is reported that 281 people in Bihar, about 650 in Nepal lost their life and thousands of people were injured. The disaster left behind a trail of devastation, rendering thousands of people shelterless. This earthquake resulted in almost complete collapse of Kutchcha rural construction in Darbhanga district and caused heavy damages and loss of lives in Dharan, Dhankuta, Tehrathum, Udaypur and Ilam districts in Nepal and, Munger, Madhubani, Saharsa and begusarai districts in Bihar. It had damaging effect up to Jogbani and was reported to have been felt as far as Gangtok, Agartala, Shillong, Calcutta and Delhi etc. Peoples were roused from their sleep by the rumbling noise that accompained the earthquake. Initial confusion gave way to panic and they rushed out of their homes.

Theextent of area affected by the earthquake was identified keeping in view the information provided by Door Darshan, All India radio news bulletin and News Paper reports. Macroseismic studies were undertaken to prepare isoseismal map of the earthquake. The data on the effects of the earthquake has been collected through a questionnaire obtained from the Post Masters of the post offices in the affected region and using the instrumental data, i.e. the data of Structural Response Recorders, which was collected by the Scientists of the Deptt. of Earthquake Engg. (DEQ) from various sites in the affected region [2].

A total of 800 questionnaires were dispatched/distributed to all the post offices as well as to the various organizations and, a response from about 30% was received. On the basis of these responses, isoseismals of various intensities (VII to VI) on Modified Mercalli scale are drawn (Fig. 1). Since the questionnaires were obtained only from post offices lying within India, isoseismal have not been drawn in detail for Nepal.

EARTHQUAKE EPICENTER

Preliminary determination of epicenter supplied by Indian Meteorological Deptt., (IMD), New Delhi are as follows.

Origin Time	23 H 09M 11.25 Sec. (GMT)
Latitude	26.775 N
Longitude	86.609 E
Focal depth	71 Km.
Magnitude	6.6

EVALUATION OF MM INTENSITY

The MM intensity in Bihar region was assigned by analysing the questionnaires, which were sent out by the Department of Earthquake Engineering, whereas, the intensity in Nepal region was assigned according to Television and News paper reports.

Questionnaire

Prepared questionnaire for evaluating seismic intensity at site contains 22 items of questions. Several items are for asking the respondent's physical situations of residential house, house type, floor number etc. and the non-physical situations in which state he or she encounters a shock. All items in questionnaire are made with reference to the text in Modified Mercalli scale [1,3].

Intensity Assignment

Intensity VIII+ was assigned where, (i) more than hundred people were reported killed resulting from collapse of large number of buildings (especially in Nepal) and (ii) ground cracks were observed. Intensity VIII was assigned at sites where, considerable damage has occurred in ordinary structures, very heavy in poorly built buildings (Kutchcha houses) and some heavy furniture overturned.

The intensity VII was assigned to those points where every one ran outdoors, slight to moderate damage in well built buildings was observed and considerable damage occurred in poorly built buildings.

Intensity VI was assigned to points where the earthquake was felt by all the peoples and where they heard the loud rattling of windows & doors, many people were frightened, objects kept on racks and shelves fell down and slight damage occurred in some good brick-masonry houses and few instances of fallen plasters were observed. The places, where many peoples awakened, dishes, windows broken, unstable objects moved, disturbances of trees were observed, have been kept in the intensity range less than VI.

Response of SRRs giving the information on the response of the buildings during the earthquake has also been studied for a peculiar case i.e. acceleration response of a four storey building (0.4 sec period and damping 5% of critical) as fraction of 'g'. A total of 41 observations have been made and plotted in Fig. 1.

ISOSEISMAL MAP

Figure 1 represents the delineation of isoseismals as per Modified Mercalli scale. Isoseismals VI to VIII were determined by plotting the points where the intensity was estimated, and then modified according to the spectral acceleration values. However, intermediate isoseismals may also be fitted if sufficient data are available. Isoseismal for intensity VIII+ could not be drawn due to insufficient number of points bearing the intensity VIII+. However, study of isoseismals reveals north of Ganges as the region where the maximum intensity was reached. The alluvium thickness is quite high in this region (more than 1000 mts.). The intensity decreases towards shallower basement as well as beyond the boundaries (Munger-Saharsa ridge) of negative anomaly (Fig. 1). Isoseismals below VI are not shown, since they can not be adequately differentiated.

The intensity VIII+ was observed at Dharan, Dhankuta, Tehrathum, Ilam, Udaypur and Jogbani where maximum damage occurred. Quoting Hindustan Times report, dated August 22, 1988, 'in Vivjipur area of Dharan town 90% of buildings were damaged and over 150 people lost their lives'.

Isoseismal VIII encloses the region of Darbhanga, Madhubani, Samistipur, Saharsa Medhepura, Purnia and the places where the value of spectral acceleration was 0.37 g and more for a structure of period 0.4 sec and damping 5% of critical. In Darbhanga, roads have cracked at many places with sand and water gushing out. The shape of isoseismal indicating intensity VIII is more or less elliptical in shape.

The area bounded by isoseismal VII marks the places with spectral acceleration less than 0.37 g and more than 0.165 g and the regions of Sitamarhi, Muzaffarpur, Vaishali, Begusarai, Khagaria, Madhepura, Munger and Purnia. About 15,000 houses were damaged in Munger, while in Begusarai the swollen river flooded nearly 50 villages. Vast areas in the district were also water logged following land breaches at several places.

In the area bounded by Isoseismal VI, Munger, Nalanda, Patna, Saran, Nalanda and Champaran etc. are the important regions where damage has been considerable. The places with spectral acceleration value 0.165 g and less have also been included in this isoseismal.

The intensity below VI covers the regions Bhagalpur, Bhojpur, Nawada, Gaya and Giridih etc.

CONCLUSIONS

The area of high intensity occurs where the thickness of alluvium is quite high and it decreases towards the shallower basement. It is also to be noted that as soon as we go beyond the boundaries (Munger-Saharsa ridge) of negative anomaly the intensity decreases.

The shape of isoseismals follow the general structural trend in the region.

The enhancement of intensity (VIII+) at various places in Nepal may be interpreted as the effect of topography, caused by amplification of ground motion on top of the hill as well as on the hill slopes.

If we extend the Patna fault towards Nepal side it seems that the epicentre lies in the vicinity of the fault.

ACKNOWLEDGEMENTS

Author is grateful to Prof. and Head of the Deptt. of Earthquake Engg. for extending necessary support in preparation of this paper. Thanks are due to Prof. L.S. Srivastava for his critical remarks on this paper.

REFERENCES

1. Indian Standard (1986), "Criteria for Earthquake Resistant Design of Structures", Indian Standard Institutions, New Delhi.

2. Mathur, B.C. (1988), "Report on Performance of Strong Motion Instruments in Bihar-Nepal Earthquake of Aug. 21, 1988", EQ 88-16, (unpublised).

3. Richter, C.F. (1958), "Elementry Seismology", W.H. Freeman and Company, San Francisco and London.

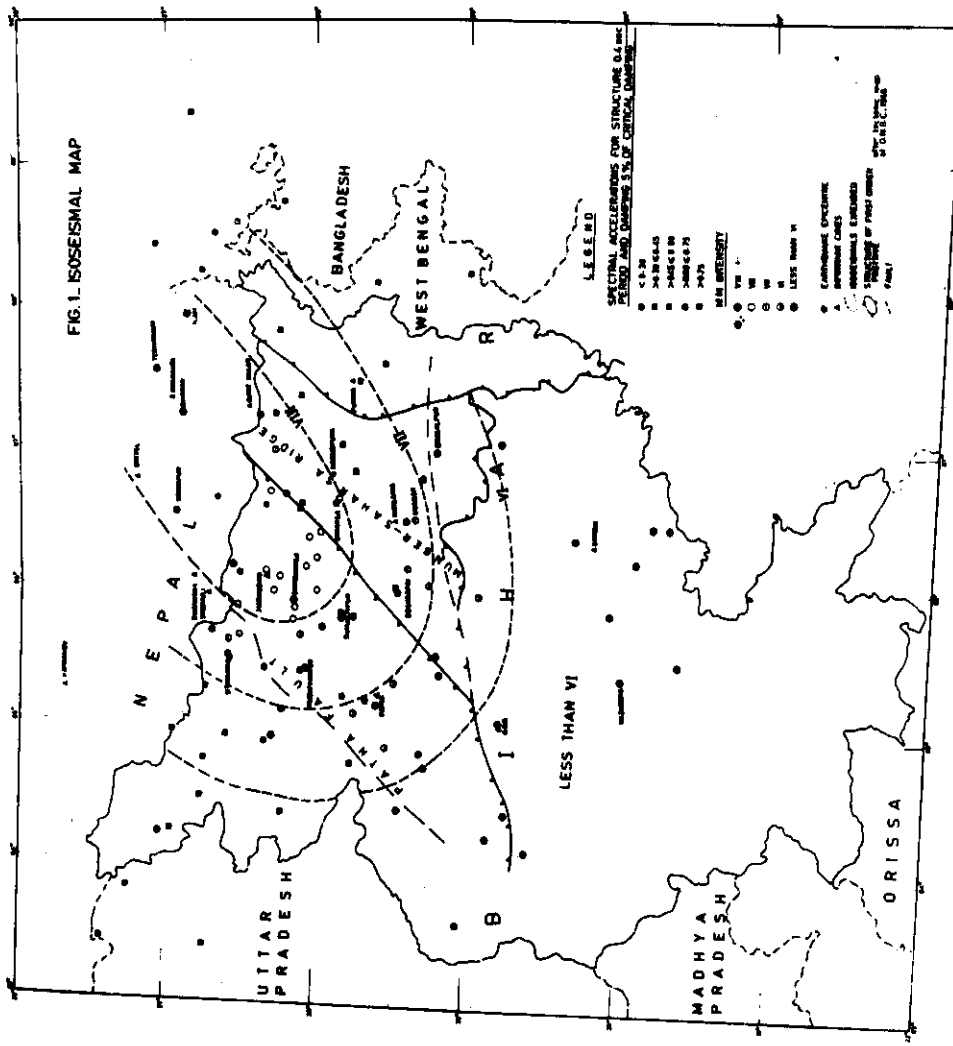
FIG.1. ISOSEISMAL MAP
BANGLADESH
WEST BENGAL
NEPAL
BIHAR
UTTAR PRADESH
MADHYA PRADESH
ORISSA
LESS THAN VI
LEGEND