A SEISMIC RISK CONTOUR MAP FOR NICARAGUA

by

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SYNOPSIS

An Iso-Contour Risk Map is developed for Nicaragua based on previously developed probabilistic seismic risk maps for different future time periods and different risk levels. The chart accompanying the Iso-Contour Map provides the peak ground acceleration value for the desired return period for design. Peak ground acceleration values for locations other than at the contour lines are obtained by interpolation between contours. Improved acceleration zone graphs for major cities in the county are also included in this paper.

INTRODUCTION

In the effort to provide a basis for design, planning and decision making for future construction in Nicaragua, a study was undertaken to develop procedures which would aid the engineers and decision makers in their task. This paper presents the results from the first part of the study in which a seismic risk map for the county is obtained based on geologic, seismologic, and probabilistic frequency information. The resulting Iso-Contour Risk Map represents future probable seismic loadings throughout Nicaragua and reflects the earthquake risk at each site. Modified acceleration zone graphs for major cities in the country are also presented.

It should be noted that the work and the results depend on the availability of earthquake data and geologic and seismologic information. The reliability of the results is at best as good as the reliability of the information. However any new information for any one of the steps in the procedure can be easily included to update the Iso-Contour Map.

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SEISMIC RISK MODELING

A Poisson probability model is used to obtain the event probabilities for different seismic sources. The seismic sources are modeled as line and area sources. For Nicaragua, nine line and four area sources are identified (Table 3-2, Ref. 1). Frequency of occurrence information for each source is conveyed through recurrence relationships. For that purpose 615 past earthquake events from Nicaragua and its vicinity covering a time period of 73 years is used. The data ranges from 5 km to 215 km in focal depth and from 3.0 to 7.7 in Richter magnitude. This data was sorted according to their location with respect to the sources and focal depths. When the cumulative number of events vs. Richter magnitude was plotted on log-linear scale, it was observed that past earthquake data is better represented through a bi-linear recurrence relationship rather than a single line relationship. The regression parameters for each source and each line segment are normalized to the length or area of each source and the time period of each data. (See Table 3-3, Ref. 1).

Using the Poisson model and Esteva's 1973 attenuation relationship, the cumulative probability distribution on peak ground acceleration at a site due to all line and area sources can be determined. Then for any specified risk level (or probability of exceedence) the corresponding peak ground acceleration can be obtained.

ISO-CONTOUR RISK MAP

The procedure described above is applied to obtain iso-acceleration maps for Nicaragua for different risk levels and different future time periods (Refs. 1, 3). The peak ground acceleration is obtained at grid points throughout the country. Contour lines for equal acceleration levels are then drawn using interpolation between grid points. Since it is not practical to have a separate map for each design situation, a single Iso-Contour Map is developed (Figure 1), from which one can obtain the iso-acceleration map for the desired return period. Table 1 gives the relationship between the contour lines, return periods and peak ground acceleration values. It should be pointed out that the contour lines do not separate zones of equal acceleration. On the contrary, if a site is between two contours, the corresponding peak ground acceleration value should be obtained through interpolation between contours. In general, to obtain the peak ground acceleration value for design and analysis purposes, the engineer needs to specify the economic life of the structure and the acceptable risk level. The return period then can be obtained from Table 2-2 (Ref. 2). For the desired site, the contour lines bounding the site are then located and their peak ground acceleration values with the specified return period are obtained from Table 1. The desired peak ground acceleration value is computed through interpolation of acceleration values at the bounding contours.

For 11 major cities in Nicaragua, separate acceleration zone graphs are presented. These graphs can be used directly instead of the Iso-Contour Map. The information on seismic hazard from these graphs is used to evaluate the insurance risk at these cities. The risk is represented in terms of expected median loss per $1000.00 value for a given class use and occupancy of structure. Using the concept of space averaging, the cities are then divided into two categories. The low seismic insurance risk is given to category I which includes Matagalpa, Esteli, San Carlos, Juigalpa and Bluefields. Category II is given to the cities with high seismic insurance risk and they include the cities of Managua, Leon, Granada, Masaya, Chinandega and Rivas.

CONCLUSION

The Iso-Contour Map developed for Nicaragua will enable engineers to design structures according to the risk present at the different locations in the country. The map and the acceleration zone graphs give information on the frequency of occurrence, probability of occurrence and the degree of severity of occurrence.

REFERENCES

1. Shah, H., Mortgat, C., Kiremidjian, A. and Zsutty, T., "A Study of Seismic Risk for Nicaragua, Part I", Technical Report No. 11, The John A. Blume Earthquake Engineering Center, Stanford University, January 1975.
2. Shah, H., Zsutty, T., Mortgat, C., Kiremidjian, A. and Dizon, J., "A Study of Seismic Risk for Nicaragua, Part II, Commentary", Technical Report No's. 12A, 12B, The John A. Blume Earthquake Engineering Center, Stanford University, March 1976.
3. Shah, H., Mortgat, C., Kiremidjian, A. and Zsutty, T., "A Study of Seismic Risk for Nicaragua", The Fifth European Conference on Earthquake Engineering, Sept. 22-25, 1975, Istanbul, Turkey.

Table 1

Peak Ground Acceleration in Percentage of g

	Return Period - Years				
Contour Line	1000	500	200	100	50
I	5	5	3	3	3
II	15	15	12	10	10
III	30	25	22	20	20
IV	40	35	30	25	25

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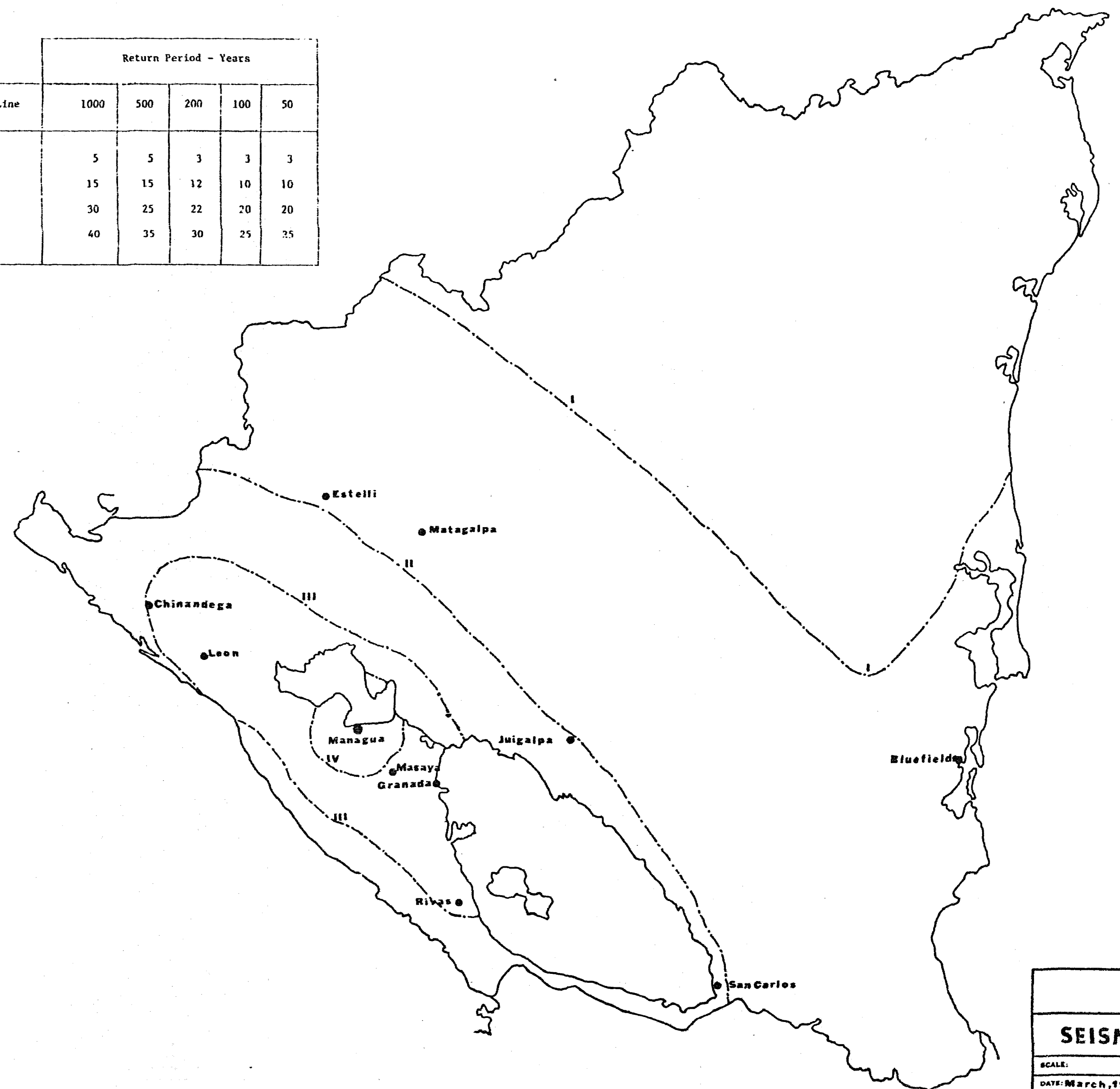

NICARAGUA

SEISMIC HAZARD MAP

SCALE:
DATE: March, 1976
FIGURE 1
DRAWN BY
REVISED

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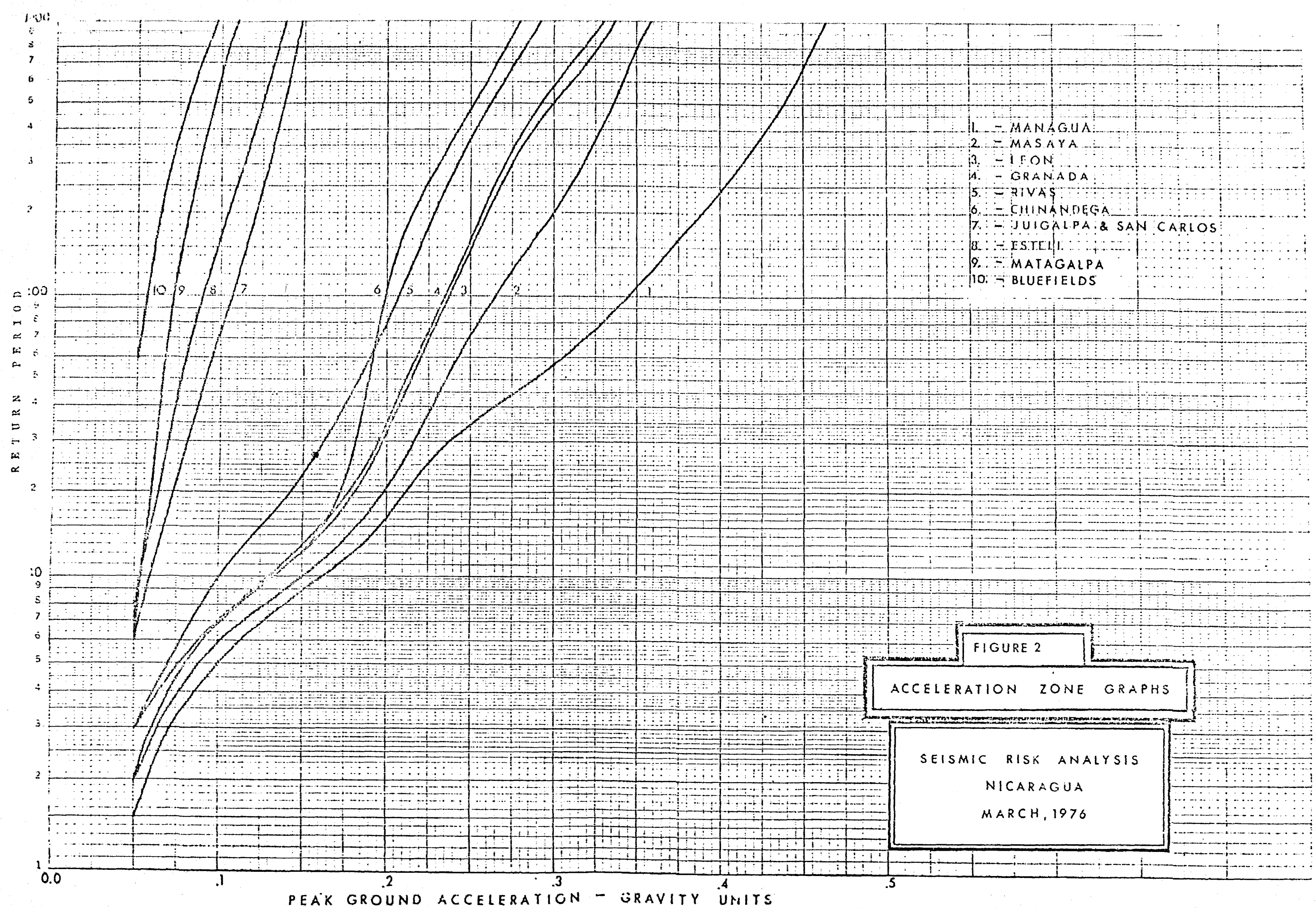
Stanford, California 94305

DRAWING NUMBER


1. – MANAGUA
2. – MASAYA
3. – LEON
4. – GRANADA
5. – RIVAS
6. – CHINANDEGA
7. – JUIGALPA & SAN CARLOS
8. – ESTELI
9. – MATAGALPA
10. – BLUEFIELDS
RETURN PERIOD
PEAK GROUND ACCELERATION – GRAVITY UNITS
FIGURE 2
ACCELERATION ZONE GRAPHS
SEISMIC RISK ANALYSIS
NICARAGUA
MARCH, 1976

DISCUSSION

C.T.J. Bubb (Australia)

There is obviously a great deal of information needed not given in the paper. Is there more detailed information freely available on request ?

R. Guzman (U.S.A.)

The discussor would like to ask you how did you consider the geologic information, because the discussor gets the impression that you seismic map is very dependent on historic seismicity. Considering the short period of observations the approach may lead to totally unrealistic results.

Author's Closure

Not received.