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**ESTIMATED SEISMIC INTENSITIES IN MEXICO CITY IN THE
SEPTEMBER 19, 1985 EARTHQUAKE BY A QUESTIONNAIRE**

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SUMMARY

In this research, the seismic intensities in Mexico City have been estimated for the time of the September 19, 1985 Mexico Earthquake by a questionnaire survey. By the results, those seismic intensities ranged from IV to VI by the intensity scale of Japan Meteorological Agency (JMA seismic intensity scale) and those intensities are affected by the ground layers condition, and coincide with the tendency of the distribution of the damaged structures.

INTRODUCTION

At that time of the September 19, 1985 Mexico earthquake, a large number of buildings had been damaged severely by the earthquake ground motions in Mexico City, in spite of long epicentral distance of 350 kilo-meters.

At that time, the earthquake strong motions had been recorded at the five stations in the city. These strong-motion seismographs have contributed to many studies on the damages caused this earthquake and on the dynamic ground characteristics in Mexico City. But the number of the stations were not enough, so that they did not cover on the whole area of the city.

Then, in order to make clear seismic intensities in various places of the city, one survey has been enforced with questionnaires method by authors.

OUTLINE OF SURVEY

Form of the data sheet of questionnaire:

This survey was investigated by the method of Prof. Ohta and et al. (Ref. 1). But the data sheet form for this investigation was used the type that was selected from the question items in original sheet and translated from Japanese to Spanish. (See Appendix 2)

Question items are composed of four kinds of items;

- (1) to ask on the position of the replyer and own house, and own movement during the earthquake. (see Appendix 2 A - C)
- (2) to ask on the structural characteristics of the house. (see Appendix 2 D - G)
- (3) to ask on the physical phenomenon that were generated during to earthquake. (see Appendix 2 H - H)
- (4) to ask on the physiological phenomenon and psychological phenomenon. (see

Appendix 2 L - R)

Interviews for the investigation:

We visited every house and questioned to every person of the house about the question items in the period from the 5th to 10th of November 1985 after about one and half months.

Determination of the stations, houses, and persons for the survey:

It had been decided that the eleven stations would be used for the investigation, and about 20 data of sheets answered had been required for each station. The stations, buildings and persons were selected under the following conditions.

- 1) The stations must be involved the sites recorded the earthquake accelerations.
- 2) The stations have to be located in both damaged and undamaged zones.
- 3) The stations have to be located in various kinds of zones. (Lake zone, hilly zone and transitional zone.)
- 4) The houses or buildings must be with only one or two stories. If in the cases of the taller building, replier must be confirmed inhabitant who live in the house on lower story floor.
- 5) Every replier for this survey must be an inhabitant of the house and he was in his house during the earthquake.

According above restrictions, eleven stations had been established and these stations have each area of about two or three hundred square meters, but two or three stations have exceptionally more grand area.

METHOD OF ESTIMATION OF SEISMIC INTENSITIES AND RESULTS

Method of estimation:

Seismic intensity for each data has estimated by the method of Prof. Ohta and et al. Original method has 25 items for the estimation of seismic intensity, but this survey has only 13 items. Then some examinations on this problem have down with the data of another suervey (Ref. 2), accordingly the affects of the difference of numbers of items is not so large.

For each stations, seismic intensity was estimated with mean value for the data in each zone.

These seismic intensities were showed with JMA(Japan Metrogical Agency) seismic intensity scale, then this scale is compared with another international seismic scales Appendix 1.

Seismic Intensities:

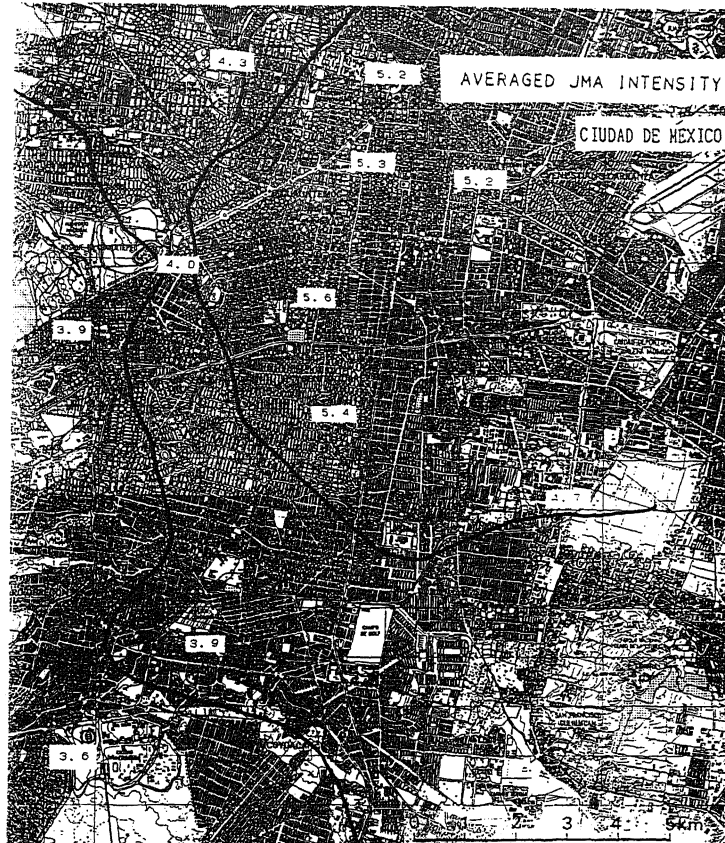
The seismic intensity distribution is shown by Fig. 1 and Table 1. Fig. 1 shows that the storongest shaking area coinsides with lake zone, while more weake and medium shaking area coincide with hilly and transitional zones. The seismic intensity values range from 5.2 to 5.6 in the lake zone, from 3.9 to 4.3 in the transitional zone, and from 3.6 to 3.9 in hilly zone. It is shown in Table 1 that estimated seismic intensities coincide with maximum acceleration recorded. (see Appendix 1)

The dynamic characteristics in the grounds in Mexico City differs greatly among three zones and the type of seismic intensity distribution is very simple.

Tendency of the replys on each questions:

For the comparision between the tendencies of the physical pehomenon and the tendicies of the physiological and psicological phenomenon in replys in this survey, some histograms of the replys for any items are shown in Fig. 2. In these

JMA	MM	MSK	α/g	Acc. Velo.
0	I	I	0.001g	0.1
0.8	I	I	0.001g	0.1
1	II	II	0.001g	0.1
1	II	II	0.001g	0.1
2.5	III	III	0.001g	0.1
2.5	III	III	0.001g	0.1
2.5	III	III	0.001g	0.1
2.5	III	III	0.001g	0.1
4	IV	IV	0.01g	1
8	IV	IV	0.01g	1
8	IV	IV	0.01g	1
8	IV	IV	0.01g	1
10	V	V	0.01g	1
10	V	V	0.01g	1
10	V	V	0.01g	1
10	V	V	0.01g	1
21	VI	VI	0.01g	1
21	VI	VI	0.01g	1
21	VI	VI	0.01g	1
21	VI	VI	0.01g	1
25	VI	VI	0.01g	1
25	VI	VI	0.01g	1
25	VI	VI	0.01g	1
25	VI	VI	0.01g	1
250	IX	IX	0.3g	300
250	IX	IX	0.3g	300
250	IX	IX	0.3g	300
250	IX	IX	0.3g	300
400	IX	IX	0.4g	400
400	IX	IX	0.4g	400
400	IX	IX	0.4g	400
400	IX	IX	0.4g	400
432	X	X	0.5g	500
432	X	X	0.5g	500
432	X	X	0.5g	500
432	X	X	0.5g	500
800	XI	XI	0.7g	800
800	XI	XI	0.7g	800
800	XI	XI	0.7g	800
800	XI	XI	0.7g	800



Appendix 1. Comparison of Various Seismic Intensity Scales.

Fig. 1. Distribution of Seismic Intensity in Mexico City. (by the JMA scale)

histograms, the degrees of the intensity of the phenomenon are shown by the have similer tendencies. Namely the repliers in lake zones had selected to high grade categories for every item in comparison with the repliers in another zones, and the other way the repliers in hilly zone and in transitional zone had selected to more lower grade categories.

When we had interviewed to repliers, large numbers of them replied to us that they had been "praying to God" during the earthquake, selecting to category 2 of the item 0 in Appendix 2.

The reply of "praying to God" was not contained in categories of any item, but we think that it is very important reply in Mexico, but still now we do not find out a estimation method on it. Then item 0 is excepted for the estimation of seismic intensity.

CONCLUSION

This survey had done under very ristric conditions, then more detail survey is required. However in this research, it is shown that the seismic intensities in Mexico City are very different and they were ranged from 3.6 to 5.6 in JMA scale. The differences of the seismic intencities were affected by the kinds of grand layers.

Table 1. Estimated Seismic Intensities in Mexico City.

NO.	Station	Number of data	Estimated Intensity (JMA)	Max. Accele. (gal)	Zone	Damage and Builds
1	Near UNAM	31	3.6	39(EW)	Hilly	No Tall & Low
2	COYOACAN	12	3.9	44(NS)	Transition	No Low
3	Abastos	25	4.7	95(EW)	Lake & Trans.	Little Low
4	Near SCT	18	5.4	168(EW)	Lake	Damage Tall & Low
5	HIDALGO (TACBAYA)	23	3.9	34(NS)	Hilly	No Low
6	General Hospital	21	5.6	-----	Lake	Damage Tall & Low
7	ZOCALO & ALAMEDA	20	5.3	-----	Lake	Damage Tall & Low
8	TOLATE-LOLCO	19	5.2	-----	Lake	Damage Tall
9	PENITECIARIA	22	5.2	-----	Lake	A Little Low
10	CHAPU-LUTEPEC	20	4.0	-----	Transition	No Low
11	CRUZ GALBEZ	23	4.3	-----	Transition	No Low

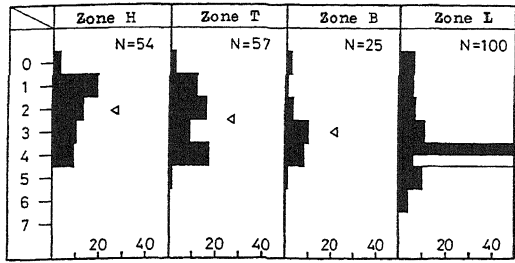
ACKNOWLEDGMENTS

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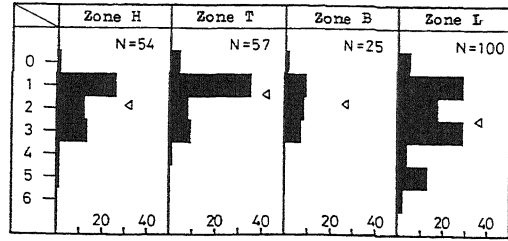
And this research is one of the fruits of the party for the survey on 1985 Mexico earthquake of the Architectural Institute of Japan. Authors present the gratitude to Prof. H. Kanoh, who is the leader of the party, and other it's members.

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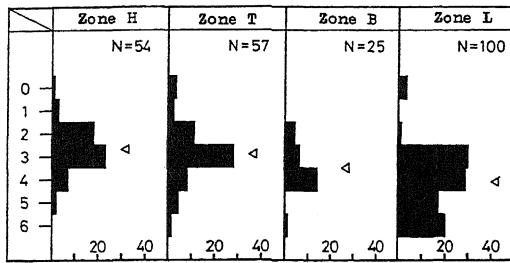
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2. Abeki, N., Mochizuki, T., Shiono, K., Tanaka, N., "Distribution of estimated seismic intensities by a questionnaire survey in the central area of Tokyo," Proc. 7th Japan Earthquake Engineering Symposium, (1986) (in Japanese)



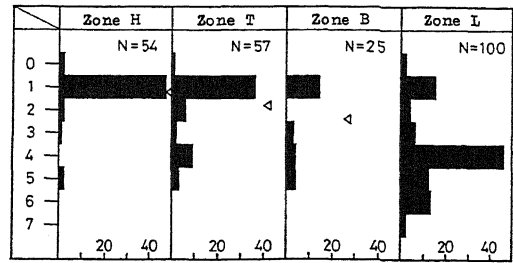
H. On the grade of moving of diner sets, windows, doors and another similarities.



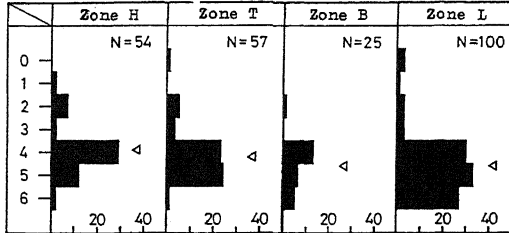
I. On the grade of moving of wardrobes, sideboards, bookshelves and another similarities.



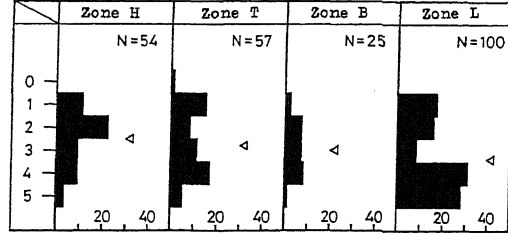
J. On the grade of shaking of the house or building.



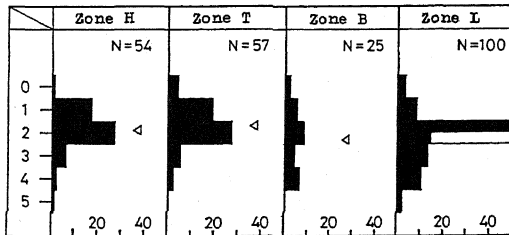
K. On the grade of the damage of the house or building.



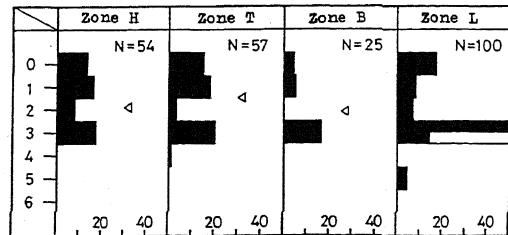
L. On the length of the time had been felt by the replier during the earthquake.



N. On the grade of the replier's during the earthquake.



O. On the replier's behavior for own's safety during the earthquake.



R. On the grade of the difficulties in own's acting during the earthquake.

Fig. 2. Histograms of Repls for Some Question Items.

Zone H—Hilly Zone, Zone T—Transrtional Zone
 Zone L—Lake Zone, Zone B—Boundary of T and L

ENCUESTA SOBRE EL TERREMOTO

(A) DIFICILILIO :

(B) ¿DÓNDE ESTABA USTED CUANDO SUCEDIÓ EL TERREMOTO?
1. ESTABA EN LA CASA (Ó. EDIFICIO)
2. ESTABA FUERA

(C) ¿QUÉ ESTABA HACIENDO EN ESE MOMENTO?

(LA PERSONA QUE ESCOJA 1 O 2 ENCIERRE EN UN CÍRCULO LA PALABRA ADECUADA)
1. ESTABA EN MOVIMIENTO
(TRABAJANDO, CANTINANDO, HACIENDO EJERCICIO)

2. ESTABA ESTÁTICO
(ACOSTADO, SENTADO, PARADO)

3. ESTABA DURMIENDO
4. OTROS ()

(D) CONTESTE LA PERSONA QUE ESTABA DENTRO DE LA CASA (Ó EDIFICIO) EN ESE MOMENTO.
¿CUAL ES LA ESTRUCTURA DE LA CASA (Ó EDIFICIO)?

1. LADRILLO 2. PIEDRA 3. HORMIGÓN 4. ARMAZÓN
5. MADERA 6. OTROS ()

(E) ¿CUÁNTOS PISOS TIENE EN ESA CASA (Ó EDIFICIO)?

1. UNA SOLA PLANTA 2. DOS PLANTAS 3. DE 3 A 5 PISOS
4. DE 6 A 9 PISOS 5. MÁS DE 10 PISOS

(F) ¿EN CUÁL PISO ESTUVO USTED EN ESE MOMENTO?

1. SÓTANO 2. PLANTA BAJA 3. PRIMER PISO 4. DE SEGUNDO A CUARTO PISO
(G) ¿CUÁNDO SE CONSTRUYÓ ESA CASA (Ó EDIFICIO)?

1. ÚLTIMOS 1 O 2 AÑOS 2. RELATIVAMENTE NUEVO 3. VIEJO 4. MUY VIEJO
(H) ¿NOTÓ ALGÚN MOVIMIENTO EN LAS VAJILLAS, LAS VENTANAS O LAS PUERTAS?

1. NO NOTÓ NADA 2. HICIERON RUIDO LIGERAMENTE 3. SE MOVIERON CON RUIDO
4. SE MOVIERON CON GRAN RUIDO 5. SE MOVIERON MUY INTENSAMENTE Y RESULTÓ ALGUNA
ROTURA EN LAS VAJILLAS, LOS VIDRIOS O SE DESGLOZARON LAS PUERTAS.

6. NOTÓ MUCHO EL DAÑO EN LAS VAJILLAS, LOS VIDRIOS 7. SE DESTRUYÓ CASI TODO
(I) ¿NOTÓ EL MOVIMIENTO DE LOS MUEBLES PESADOS? (POR EJEMPLO EL LIBRERO, EL APARADOR Y EL ARMARIO)

1. NO SE MOVIERON 2. SE MOVIERON LIGERAMENTE 3. SE MOVIERON BASTANTE
4. SE DESLIZARON POCO 5. SE DESLIZARON MUCHO Y SE CAYERON
6. SE CAYERON CASI TODOS

(J) ¿CÓMO SE MOVIÓ LA CASA (Ó EDIFICIO) EN GENERAL?

1. NO NOTÓ NADA 2. SE MOVIÓ LIGERAMENTE 3. SE MOVIÓ BASTANTE
4. SE MOVIÓ INTENSAMENTE 5. SE MOVIÓ MUY VIOLENTAMENTE
6. SE MOVIÓ COMO SI SE CAYERA

(K) ¿HUBO ALGÚN DAÑO EN LA CASA (Ó EDIFICIO)?

1. NO HUBO NADA 2. SE DESLIZARON O SE INCLINARON LOS CUADROS Y LOS ADORNOS
3. SE CAYERON LOS CUADROS, LOS ADORNOS, LOS FLOREOS Y LAS CRISTALERÍA
4. SE PRODUCIERON PEQUEÑAS GRIETAS EN LAS PAREDES
5. SE PRODUCIERON GRANDES GRIETAS
6. EL DAÑO FUE BASTANTE GRAVE Y SE NECESITA ARREGLAR
7. SE NOTÓ MUCHO LA INCLINACION DE LA CASA

(L) ¿CÓMO SINTIÓ USTED EL TIEMPO EN QUE ESTUVO TEMBLANDO?

1. MUY CORTO 2. CORTO 3. NO SE PUEDE DEFINIR 4. LARGO
5. MUY LARGO 6. NO SE PODIA SABER CUANDO TERMINARÍA

(M) ¿CUAL TIPO DE MOVIMIENTO SINTIÓ MÁS INTENSAMENTE?

1. COMO SI SE EMPUJARA HACIA ARRIBA 2. BALANCED REPETIDO CON MUCHO RAPIDEZ
3. BALANCED CON LENTITUD 4. NO PODIA DISTINGUIR
5. OTROS ()

(N) ¿SE ASUSTO USTED CUANDO SE DIÓ CUENTA DEL TERREMOTO?

1. NO SE ASUSTÓ 2. SE ASUSTÓ POCO 3. SE ASUSTÓ BASTANTE
4. SE ASUSTÓ MUCHO 5. SE ASUSTÓ MUCHÍSIMO

(O) ¿CÓMO REACCIONÓ USTED EN ESE MOMENTO?

1. NO SINTIÓ LA NECESIDAD DE HACER ALGO
2. PENSÓ TOMAR ALGUNA PRECAUCIÓN PARA PROTEGERSE
3. HUYÓ FUERA CONSCIENTEMENTE 4. HUYÓ FUERA CASI INCONSCIENTEMENTE
5. NO RECUERDA PORQUE REACCIONÓ SOLO POR INSTINTO

(P) ¿QUÉ HIZO USTED CON LOS FUEGOS QUE HABIA EN SU CASA (POR EJEMPLO LA ESTUFA) EN ESE MOMENTO?

1. NO ESTABA ENCENDIDO
2. NO SINTIÓ LA NECESIDAD DE APAGAR AUNQUE ESTABA ENCENDIDO
3. APAGÓ PORQUE SINTIÓ EL PELIGRO 4. APAGÓ INCONSCIENTEMENTE
5. NO PODIA APAGAR PORQUE PERDIÓ LA CALMA

(Q) CONTESTE LA PERSONA QUE ESTABA DURMIENDO EN LA CASA EN ESE MOMENTO
1. EXCEPTO YO, TODOS ESTABAN DESPERTOS 2. POCAS GENTE SE DESPERTÓ
3. CASI TODA LA GENTE SE DESPERTÓ 4. TODA LA GENTE SE DESPERTÓ

(R) CONTESTE LA PERSONA QUE ESTABA HACIENDO ALGO EN ESE MOMENTO
1. NO SINTIÓ NADA DE IMPEDIMENTO PARA ACTUAR
2. SINTIÓ POCO IMPEDIMENTO PARA ACTUAR 3. FUE DIFÍCIL ACTUAR
4. SE TIRO AL SUELO 5. SE CAYÓ