"SOME CONSIDERATION ABOUT THE EFFECT OF MEXICAN EARTHQUAKES"

By J. Figueroa A.

PERIODS

Abstract

Considering the seismograms of four stations (Mazatlan, Guadalajara-Tacubaya and Veracruz), each one located on terrains of different geological constitution (rock, conglomerate, shore-fillings), the period of the - shear waves responsible for the maximum destructiveness has been measured.

Taking into account the epicentral distances from the origin to the - limit of perceptibility in macroseisms of magnitude 7 and greater (Richter Scale), the predominant and most dangerous periods encountered were: 0.75- seconds, to 1.25 seconds, particulary those of 1 second.

The influence of focal depth is considered in order to confirm that - the increase of the dimensions of the shaken block can cause destruction - in soft grounds far from the epicenter.

The calculated magnitudes are compared with the grades of intensity - felt in Mexico City.

We refer to the predominant periods of Normal Microseismic Agitation- related to meteorological phenomena and the periods of the Continuous Lo-- cal Microseisms which vary with urban activity.

When a strong shock takes place it is assumed that the transverse --- waves, in most cases, lead along the maximum seismic energy, and these waves, more than others, produce the gratest damage.

Under that consideration we made an attempt in order to know the pe-- riods connected with such effects.

Four of our stations installed on different ground foundations were - chosen because of the important role that the soil plays in the intensity- of the earthquakes.

The stations and their instrumental constants are shown in table # I.

We did a careful selection of many seismograms obtained in these stations corresponding to the epicentral distances indicated in table # II.

We prefer strong shocks of the magnitude 7 and greater (Richter ---- Scale), but when, it wasn't possible due to the fact that with domestic --

---

(1) Chief of the Seismological Service. Institute of Geophysics. National University of Mexico.

(nearby) shocks (100 Kms. or a little more epicentral distance), the re--- cording pens jumped up in many instances, making incomplete graphics, then we used seismograms of shocks of minor magnitude.

The obtained averages are shown in table II.

In this table we observe that until distances are smaller than 400 -- Kms. the period is proportional to the distance, that is to say, the lesser distance the lesser period.

Over 400 Kms. we find that the period diminishes as much as in epicen tral distances of 120 to 300 Kms.

We have found that prevailing periods in the greater part of seismo-- grams of macroseisms within the margin of distances encircled within the - limits of perceptibility are; 0.75 to 1.25 sec., particulary those of 1 -- sec., and for the finality of this work, we consider such periods as the - most dangerous.

Now then, in the course of the measurement it was confirmed that the- periods are shorter when the intensity of the earthquake diminishes.

On the other hand the periods are longer and the duration of the phe- nomenon lasts more, when the epicentral distance increases and the geolo-- gical constitution of the soil is poor (anelastic.)

In such type of soil, the natural decrement of the seismic energy by- the enlargement of the distance does not take place. On the contrary the-- values of the acceleration increase and it is obvious that if the duration increases, as we said, there will be more probabilities of resonances with the result of greater damages in badly designer or badly built construc--- tions, mainly when they are in soils with a high level of water.

In this kind of surface formations, of which we are talking about the seismic waves of shocks whose focal depth is not too shallow, have singu-- lar importance.

As a matter of fact any increment of depth means greater extension of the shaken block. This circunstance causes or is the cause that in poor -- grounds some times situated as far as 500 Kms. from the origin of an earth quake of magnitude 7.5 or greater, the intensity effects are compared only with those in the epicentral area. Heavy property damage and disasters --- have occurred.

We could mention many instances concerning Mexico City, but as a means of comparison two cases are enough:

The macroseisms June 7, 1911, destructive in Ciudad Guzman, Jal., had 100 Kms. of depth and an epicentral distance of 474 Kms. from Tacubaya (an environ of Mexico City). By this shock many persons were killed and inju-- red. Heavy property damage took place and some rails of street cars were - twisted, in the lower parts of the City of Mexico.

Now then, the source of the shallow strong shock of January 19, 1912- (magnitude 7.8, Tacubaya) was located near to Acambay and Tixmadeje. These two places in the State of Mexico only 100 Kms. far from Tacubaya were destroyed. However, in Mexico City the losses were negligible, in spite that the epicenter was closer in this earthquake than in the other.

The first earthquake was felt over an area of 500,000 Kms^2, while the second only reached 95,500 Kms^2.

After what has been said, it is useful to see in the next table III - how the Calculated Magnitudes of some earthquakes are compared with the -- grades of intensity felt in the Federal District.

That comparison shows us what ordinarly happens with shallow or deeper than normal shocks, and also confirm that the azimuth of the epicenter has not any influence in the grade of intensity.

Finally in a great number of seismograms of Tacubaya and Veracruz we- analize the inscriptions of predominant periods and amplitudes caused by- Normal Microseismic Agitation and Continuous Local Microseisms.

This agitation., as we know, are related: the former to the meteorological phenomena, the later to the urban activity.

The averages are shown in table IV.

From the former we realize that the local agitation in Tacubaya reaches periods a little more than 0.4 sec. while the amplitudes ascend at -- 10 h, 14 h, and 18 h, when there is a great deal of traffic.

Veracruz renders in general, greater periods, but smaller amplitudes, because its seismographs have lesser magnification; besides the traffic -- there, is not so intense as in Mexico City.

All what has been said, is a brief summary resulting from a great --- number of careful analysis and measurements made by three persons working- separately.

Conclusions: (according to expressed requirements.)

1 sec.	Predominant period in seismograms of stations located on hard ground.
1.22 sec.	Predominant period in seismograms of stations on less firm ground.
Longer periods	In stations on shore-fillings.
Amplitude	Greater in poor grounds.
Duration	" " " "

Acceleration	Greater in poor grounds.

Tacubaya, D. F., February 29, 1960

J. Figueroa A.

TABLE # I

STATIONS AND SEISMOGRAPHS

NAME OF THE STATIONS	FOUNDATION	LATITUDE N	LONGITUDE W	HEIGHT (meters)	SEISMOGRAPHS
Tacubaya	conglomerate	19°24'18"	99°11'57"	2297	Wiechert horizontal:-- NS-EW, Mass 17000 Kg.- V=2000. To=1.5s. speed 60 mm m. NS-EW, Mass 1200 Kg. - V=250. To=6 s., speed- 30 mm m. Wiechert vertical Z, - Mass 1300 Kg. V=150.To =6 s., speed 30 mm m. Mass 80 Kg. V=80 To=8s speed 45 mm m. 2 Bosh-Omori horizon-- tal. NS-EW, Mass 10 Kg V=15. To=15 s., speed- 15 mm m.
Mazatlan	andesite	23°11'17"	106°24'22"	65	Wiechert horizontal,NS EW, Mass 200 Kg. V=80. To=6 s., speed 12 mm m Wiechert vertical Z, - Mass 80 Kg. V=80. To=4 s., speed 12 mm m.
Veracruz	shore-fillings	19°12'02"	96°08'16"	3	Wiechert horizontal, - NS-EW, Mass 200 Kg. V= 80. To=6 s. speed 15 - mm m. Wiechert vertical Z, - Mass 80 kg. V=80. To=4 s., speed 15 mm m.
Guadalajara (Tlaquepaque)	sedimentary rock	20°40'46"	103°19'27"	1567	Wiechert horizontal, - NS-EW, Mass 200 Kg. V= 80. To=6 s., speed 12- mm m. Wiechert vertical Z, - Mass 80 Kg. To=4 s. V= 80. speed 12 mm m.

N S: North-South component

E W: East-West component

Z: vertical component

V: magnification

To: period

mm m: millimetres per minute

TABLE # II

PREDOMINANT PERIODS

Epicentral - distance in- kilometres.	S T A T I O N S			
	MAZATLAN andesite rock	GUADALAJARA (Tlaquepaque) sedimentary rock	TACUBAYA conglomerate	VERACRUZ shore-fillings
	S E C O N D S			
15 Kms.		0.3 sec.	0.5 to 0.65 sec.	
50 - 70 Kms.	0.33 sec.	0.5 sec.	0.7 "	1.5 sec.
80-100-120Kms	0.66 "	0.7 "	0.76 "	1.7 "
120 - 300 "	0.75 "	0.75 "	1.0 "	2.0 "
300 - 400 "	0.75 "	1.25 "	1.22 "	2.16-2.31 "
400 - 500 "	Limit of perceptibility in shocks of --- magnitude 7.8		0.97 "	1.9

TABLE # III

CALCULATED MAGNITUDES COMPARED WITH THE GRADES OF INTENSITY FELT IN FEDERAL DISTRICT

PERIOD SEC.	DATE	DIST. Kms.	h Kms.	COORDINATES	MAG.	INT.	ACCELERATION mm/sec^2 TACUBAYA	ROSSI FOREL
0.97	1911 VI 7	474	100	19°40' N 103°39'W	8	VIII	250 - 500	500
0.95	1912 XI 19	95-119	Sup.	19°56'N 99°50' W	7.8	V	25 - 50	110
1.00	1920 I 3	216-235	Sup.	19°16'N 96°58' W	7.8	IV	10 - 25	80
0.97	1928 VI 17	408	50-80	16°13'N 97°11' W	7.5	VI	50 - 100	150
0.97	1932 VI 18	496	50-80	19°03'N103°54' W	7	VI	50 - 100	150
1.22	1937 XII 23	334	normal	16°24'N 98°39'W	7.2	VI	50 - 100	150
0.97	1941 IV 15	452	s.d.t.n.	18°07'N 103°19'W	7	VII	100 - 250	300
1.22	1957 VII 28	336	normal	16°21'N 99°13'W	7.5	VII	100 - 250	300

Dis.: distance

h: depth

mag.: magnitude (Richter Scale)

Int.: intensity (Mercalli Mod. 1931)

sec.: second

Kms.: kilometres

Sup.: superficial

s.d.t.n.: Slightly deeper than normal

TABLE # IV

NORMAL MICROSEISMIC AGITATION

RELATED TO THE METEOROLOGICAL PHENOMENA

STATION	MEAN AMPLITUDE	PERIOD
Tacubaya horizontal	0.38 millimetres	3.9 seconds
" vertical	0.32 "	3.7 "
Veracruz horizontal	0.31 "	4.9 "
" vertical	0.12 "	3.2 "

(The values of the vertical in Veracruz may be modified by the changes in temperature The seismographs operates in a room, and even under -- this influence, notwithstanding that it has a protection against such changes.

For this reason the recorder pen some times goes on with limited sensibility and the size of inscriptions are shorter.)

CONTINUOUS LOCAL AGITATION

WHICH VARY WITH URBAN ACTIVITY

	2h		6h		10h		14h		18h		22h	
	A	To	A	To	A	To	A	To	A	To	A	To
TACUBAYA:	.41	0.42	.74	0.42	.90	0.42	1.7	0.4	.84	0.42	.67	0.4
VERACRUZ:	.11	4.72	.26	4.9	.25	4.7	.26	4.9	.24	5.25	.20	4.65

h: hours

A: amplitude

To: period

DISCUSSION

C. F. Richter, Visiting Professor at the University of Tokyo, Japan:

This valuable paper shows that in explaining intensity distributions, we must consider the effect of path, as well as of ground at the point of observation.

Seismograms of the earthquake of 1912 at European Stations indicate focal depth of over 100km. Possibly this deep earthquake caused a shallow earthquake in the Acambay-Tixmadeje District. Seismograms at short distance may be due to this shallow shock.

J. Figueroa A.:

I am grateful to Dr. Richter's comment, and I want to record my complete agreement.