Note on the Relation to the Epicentral Distance of the Duration of the Preliminary Tremor of the Earthquake Motion of near Origin.

By

F. OMORI, Sc. D.,

Member of the Imperial Earthquake Investigation Committee.

With Pl. XXXII.

In the Jour. Sc. Coll., Tokyo Imp. Univ., Vol. XI (1899), I have given, for the relation between the duration ($=y$) of the preliminary tremor at an observing place and the epicentral distance ($=x$) of the latter, the following equation :—

$$x \overset{\text{km}}{=} 7.51\, y \overset{\text{sec}}{+} 24.9 \overset{\text{km}}{\quad} \ldots\ldots\ldots\ldots\ldots\ldots (1)$$

This equation was, in the *Publications of the Earthquake Investigation Committee*, No. 13 (1903), slightly modified into the following form :—

$$x \overset{\text{km}}{=} 7.27\, y \overset{\text{sec}}{+} 38 \overset{\text{km}}{\quad} \ldots\ldots\ldots\ldots\ldots\ldots (2)$$

Both of these equations, which have been deduced from the observations of the earthquakes of x less than 1,000 km and, with a few exceptions, greater than 150 km, can not be applied to the cases of very near shocks, say, of x less than 100 km. With a view of obtaining a provisionary formula for the cases of smaller x, I have examined some of the seismograms obtained at the five Formosan meteorological observatories of Taihoku, Taichu, Tainan, Taito, and Hokoto ; the results being briefly stated in the following paragraph.

The earthquakes taken into consideration were the four destructive shocks in the years 1904 and 1906,* which I have specially studied and the positions of whose origins may be supposed to be fairly accurate. The observations were made with Omori horizontal pendulums of 6 to 10 times magnifications. The following table gives for each of the 4 shocks, the date and position of the origin of disturbance, and the epicentral distances and the durations of the preliminary tremor at the different stations.

FORMOSA EARTHQUAKES.

Date of Eqke.	Station.	Duration of Prel. Tremor $=y$ sec.	Actual Epicentral Distance $=x$ km.	Position of the Origin of Disturbance.
April 24, 1904.	Taihoku	28.7	221	$\varphi = 23° 20'$ N $\lambda = 120° 24'$ E
	Taichu	11.4	98	
	Taito	12.8	98	
	Hokoto	12.7	90	
November 6, 1904.	Taihoku	28.8	202	$\varphi = 23° 30'$ N $\lambda = 120° 26'$ E
	Taichu	11.2	76	
	Tainan	8.3	64	
	Taito	15.5	117	
	Hokoto	9.0	85	
March 17, 1906.	Taihoku	27.5	188	$\varphi = 23° 35'$ N $\lambda = 120° 32'$ E
	Taichu	9.0	65	
	Tainan	8.7	75	
	Hokoto	11.5	101	
April 14, 1906.	Taihoku	30.6	210	$\varphi = 23° 25'$ N $\lambda = 120° 30'$ E
	Taichu	12.0	88	
	Tainan	8.6	53	
	Hokoto	13.0	98	

* See the "Bulletin of the Imperial Earthquake Inv. Com.," Vol. I, No. 2.

Arranging the epicentral distances, which varied between 53 and 221 km, and dividing these conveniently into 4 groups, we obtain :—

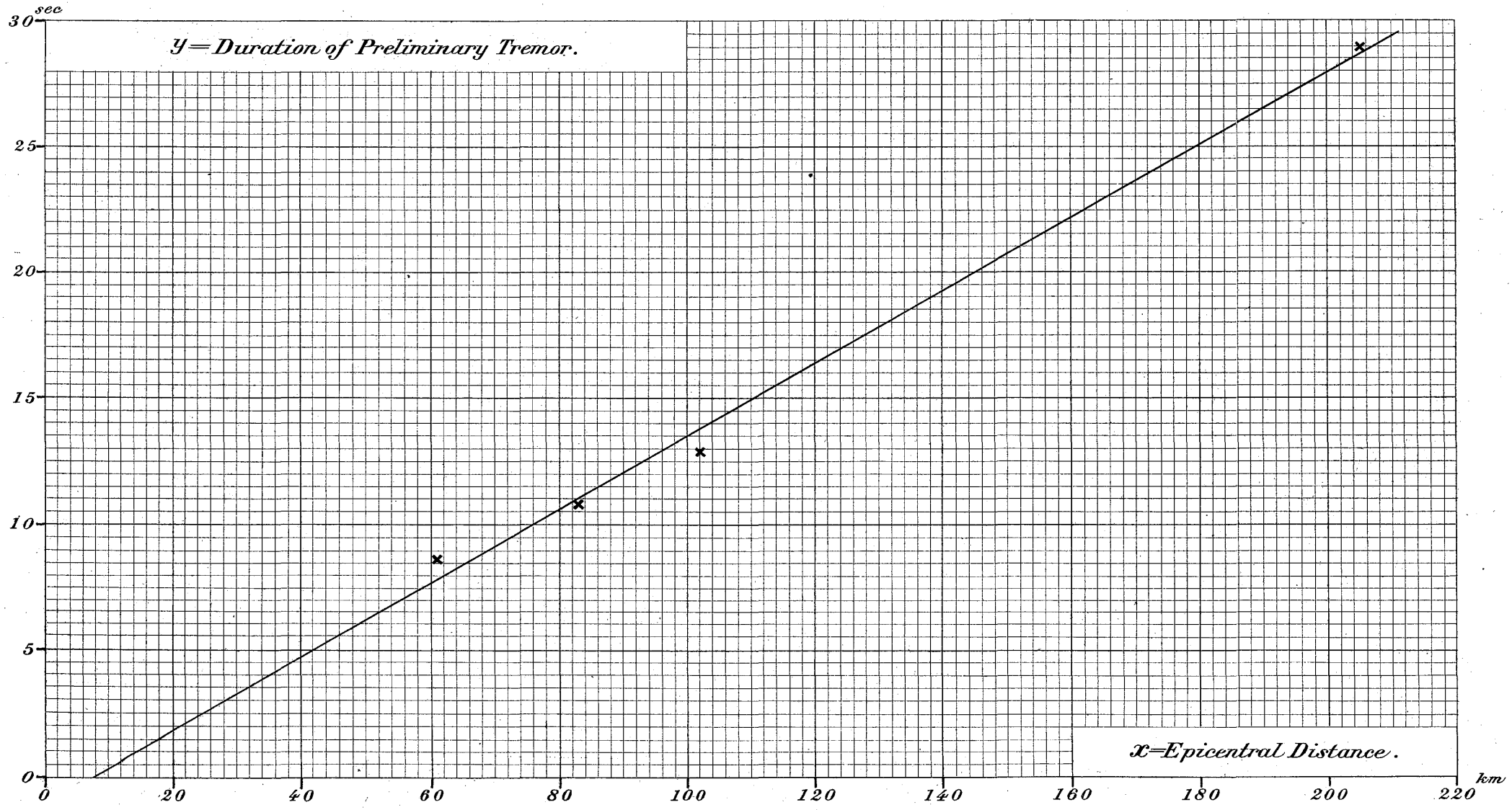
x (actual)	y	x calculated by equation (3)
221 km	28.7 sec.	
210	30.6	
202	28.8	
188	27.5	
Mean.... **205**	..... **28.9**	206
117	15.5	
101	11.5	
98	13.0	
98	11.4	
98	12.8	
Mean.... **102**	.....**12.8**	96
90	12.7	
88	12.0	
85	9.0	
76	11.2	
75	8.7	
Mean .....**83**.....	.....**10.7**	81
65	9.0	
64	8.3	
53	8.6	
Mean..... **61**.....	..... **8.6**	67

The relation between the mean values of the epicentral distance and the duration of the preliminary tremor given in the preceding table is graphically shown in the accompanying figure (Pl. XXXII). Assuming a linear equation between x and y and determining the constants from the four sets of the mean values of x and y, we obtain :—

$$x^{\text{km}} = 6.86\ y^{\text{sec.}} + 8.1^{\text{km}} \quad \ldots\ldots\ldots\ldots (3)$$

Relation between the Epicentral Distance and the Duration of the Preliminary Tremor.

(Near Earthquakes.) Formosa Observations.



The figures given in the last column of the preceding table, which have been calculated by this equation, agree closely with the actual distances.

Equation (3), which may be used under the conditions

$$50 \text{ km} < x < \text{about } 200 \text{ km},$$

seems to be more convenient for the cases of near earthquakes than Equation (1) or Equation (2); the distances calculated by the two last equations being, for a small value of y, generally larger than the corresponding actual x.