

those of  $P_4$ ,  $P_5$ , and  $P_6$  types, occurred very rarely; this circumstance arising from the fact that the earthquakes of Groups II to IX were mostly small earthquakes.

The four quick periods  $p_1$ ,  $p_2$ ,  $P_0$ , and  $p_3$ , have a mean common difference of 0,31 sec., while the seven slower periods,  $P_1$ ,  $P_2$ ,  $P'_2$ ,  $P'_4$ ,  $P_4$ ,  $P_5$  and  $P_6$ , have a mean common difference of 3,9 sec.

Comparing together tables XIV and XVI, we see that the slower periods occurring most frequently in earthquakes of distant, as well as near, origins are  $P_2$  and  $P_1$  type vibrations; these being identical with the two predominating periods of the pulsatory oscillations (§ 17).

#### **IV. Constancy of the different periods of vibration in the 1st and the 2nd preliminary tremors of the earthquakes of group I.**

§ 7. Table XVII gives the period of vibrations in the 1st and the 2nd preliminary tremors of distant earthquakes, (Group I), arranged according to the duration of the total preliminary tremor and divided into a convenient number of groups.

**TABLE XVII.**  
**CONSTANCY OF THE DIFFERENT PERIODS IN**  
**DISTANT EARTHQUAKES.**

Eq. No.	Duration of total prel. tremor.		Average periods in 1st and 2nd prel. tremors.				Eq. No.	Duration of total prel. tremor.		Average periods in 1st and 2nd prel. tremors.			
	m.	s.	sec.	sec.	sec.	sec.		m.	s.	sec.	sec.	sec.	sec.
211	0.	37	—;	8.3;	—;	—							
369	0.	40	—;	9.9;	—;	—							
368	1.	18	—;	7.7;	—;	—	338	10.	10	—;	9.6;	—;	—
17	1.	21	—;	—;	15.8;	—	269	10.	55	4.7;	9.8;	—;	25
210	1.	22	4.6;	—;	—;	—	266	11.	6	4.7;	—;	—;	—
<i>Mean</i>	<b>1.</b>	<b>4</b>	<b>4.6;</b>	<b>8.6;</b>	<b>15.8;</b>	—	<i>Mean</i>	<b>10.</b>	<b>44</b>	<b>4.7;</b>	<b>9.7;</b>	—;	<b>25</b>
380	2.	30	3.7;	—;	—;	27.4	215	12.	22	4.8;	10.2;	—;	20.5
362	3.	9	3.7;	8.1;	—;	38.0							26.8
238	3.	29	4.2;	—;	—;	—	274	12.	27	4.8;	7.8;	14.2;	19.6;
22	3.	52	—;	—;	14.5;	—	1	12.	52	—;	7.2;	13.0;	—
<i>Mean</i>	<b>3.</b>	<b>15</b>	<b>3.9;</b>	<b>8.1;</b>	<b>14.5;</b>	<b>27.4</b> <b>38.0</b>	13	12.	52	4.9;	10.2;	—;	—
233	4.	00	5.4;	—;	—;	—	224	13.	00	4.7;	8.3;	—;	—
237	4.	50	3.8;	8.3;	—;	—	<i>Mean</i>	<b>12.43</b>		<b>4.8;</b>	<b>8.7;</b>	<b>13.6;</b>	<b>20.1</b> <b>25.8</b>
28	5.	16	4.1;	10.3;	—;	—	206	14.	43	—;	8.8;	—;	—
168	6.	13	—;	10.0;	—;	—	279	15.	3	5.1;	8.6;	—;	21.2
156	6.	16	5.2;	9.2;	—;	—	8	15.	5	—;	—;	11.8;	—
285	6.	17	—;	9.0;	—;	—	126	15.	2	5.4;	—;	—;	—
<i>Mean</i>	<b>5.</b>	<b>29</b>	<b>4.6;</b>	<b>9.4;</b>	—;	—	218	15.	10	4.5;	8.8;	—;	—
111	7.	30	4.0;	7.8;	—;	—	54	15.	16	4.1;	7.5;	13.4;	—
2	7.	33	—;	—;	15.9;	—	119	16.	50	—;	—;	14.4;	—
167	8.	0	3.9;	—;	—;	—	<i>Mean</i>	<b>15.</b>	<b>19</b>	<b>4.8;</b>	<b>8.4;</b>	<b>13.2;</b>	<b>21.2</b>
377	8.	38	5.1;	—;	—;	—	275	20.	40	—;	10.2;	—;	—
259	8.	40	5.3;	9.3;	—;	—	285	20.	56	—;	8.1;	14.6;	—
94	8.	44	4.8;	—;	—;	—	11	21.	40	5.3;	7.3;	14.7;	—
<i>Mean</i>	<b>8.</b>	<b>12</b>	<b>4.6;</b>	<b>8.6;</b>	<b>15.9;</b>	—	288	32.	31	—;	7.6;	—;	32.6
256	9.	4	3.8;	8.0;	15.2;	—	133	33.	30	5.8;	8.9;	16.0;	20.0
20	9.	28	—;	—;	136;	—	<i>Mean</i>	<b>25.</b>	<b>51</b>	<b>5.6;</b>	<b>8.4;</b>	<b>15.0;</b>	<b>20.0</b> <b>32.6</b>
134	9.	30	5.9;	—;	—;	—							
376	9.	30	—;	9.5;	—;	—							
<i>Mean</i>	<b>9.</b>	<b>23</b>	<b>4.9;</b>	<b>8.8;</b>	<b>15.9;</b>	—							

The mean results obtained from the above table are as follows.

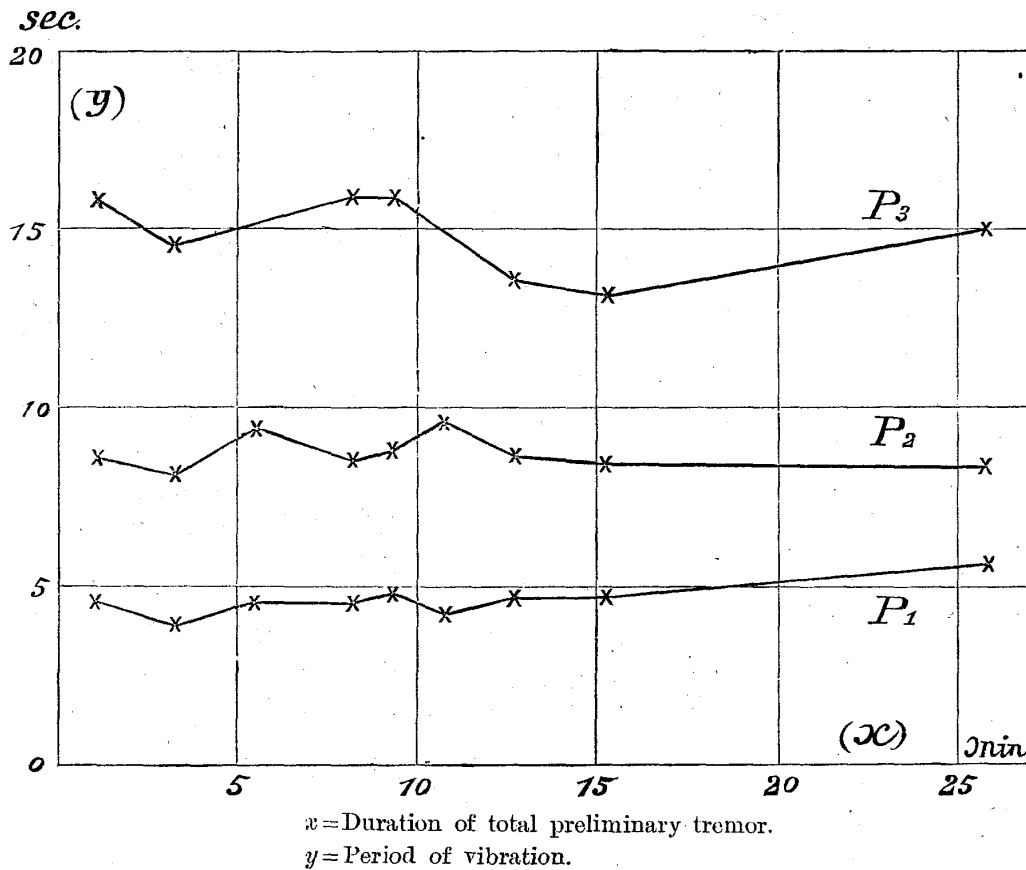
**TABLE XVIII.**

CONSTANCY OF THE DIFFERENT PERIODS IN DISTANT EARTHQUAKES. (*Continued*).

Duration of the		Periods.					
total prel. tremor.		P <sub>1</sub>	P <sub>2</sub>	P <sub>3</sub>	P <sub>4</sub>	P <sub>5</sub>	P <sub>6</sub>
m	s	sec.	sec.	sec.	sec.	sec.	sec.
1	4	4,6	8,6	15,8	—	—	—
3	15	3,9	8,1	14,5	—	27,4	38,0
5	29	4,6	9,4	—	—	—	—
8	12	4,6	8,6	15,9	—	—	—
9	23	4,9	8,8	15,9	—	—	—
10	44	4,7	9,7	—	—	25,0	—
12	43	4,8	8,7	13,6	20,1	25,8	—
15	19	4,8	8,4	13,2	21,2	—	—
25	51	5,6	8,4	15,0	20,0	—	32,6

Thus it will be seen that, in cases of distant earthquakes, the different periods, P<sub>1</sub>, P<sub>2</sub>, P<sub>3</sub>, etc., of the vibrations in the 1st and the 2nd preliminary tremors do not depend on the duration of the latter that is to say, on the distance of the earthquake origin from the observing station. (See Fig. 2.) Similar conclusion probably holds goods also for the periods in other stages of the earthquake motion. The cases of macro-seismic movements have already been discussed in the *Publications* No. 11, where it was shown that different periods varying from fractions of a second to some 2 seconds do not depend on the distance of the origin or the size of the earthquake.

Fig. 2.



### V. Relative Magnitudes of the Maximum Movements in the Different Stages of the Earthquake Motion.

§ 8. (a) *Distant earthquakes observed at Hitotsubashi.* The 1st and the 2nd preliminary tremors and the successive parts of the principal portion of the earthquake motion are characterized by the difference of amplitude as well as by that of period. The following mean values of the relative magnitudes of the maximum motions in