7. *Earth-vibrations on Soft Ground caused by Fallen Body.*

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Earth-vibrations are thought to be usually larger on soft ground than on hard ground, and earthquake damage is greater to houses elected on soft ground. The neighbourhood of some factories on soft ground is frequently disturbed by vibrations of machines. These problems are studied from seismology and from soil dynamics.[1] Recently at a steel factory in Minami-Sunamachi, Kōtōku, southeastern low ground of Tokyo, a machine was erected to compress a heep of iron scraps into small volume by letting fall a heavy iron mass of 5 tons in weight from the height 6 m. The writer made some brief observations of earth-vibrations caused by the falling mass.

Recording of the vibrations was made with mechano-optical recording tromometers designed by the writer.[2] The recording was made by two components, vertical and horizontal in longitudinal direction. The constants of the instruments were adapted to record quick and large vibrations for this case: the period of self-vibration being 2.6 sec, the geometrical magnification of horizontal or vertical components 2000–1000 and 840–420 respectively, and the damping ratio about 1.40 of both components.

Portions of record of elastic waves caused by the falling mass is shown in Fig. 1. As the results of the observation, the form of elastic waves was almost equal in every case if the position of the observation was the same. The periods of vibrations increased with the distance of observing station. The velocity of propagation of waves were obtained as 380 m/sec for the initial phase and 140 m/sec or 100 m/sec for maximum amplitudes. (But the writer considers that the values mentioned above have to be examined again, for the accuracy of the ob-

1) RUDORF K. BERNHARD, *Trans Amer. Min. Metal. Engg.*, **138** (1940), 326-349. G. ANGENHEISTER, *Ergebn. exakt. Naturwiss.*, **15**, Berlin, (1936), &c.

2) F. KISHINOUYE, *Bull. Earthq. Res. Inst.*, **20** (1942), 215. The vertical component tromometer was reported at the monthly meeting of Earthq. Res. Inst. on July 6, 1943.

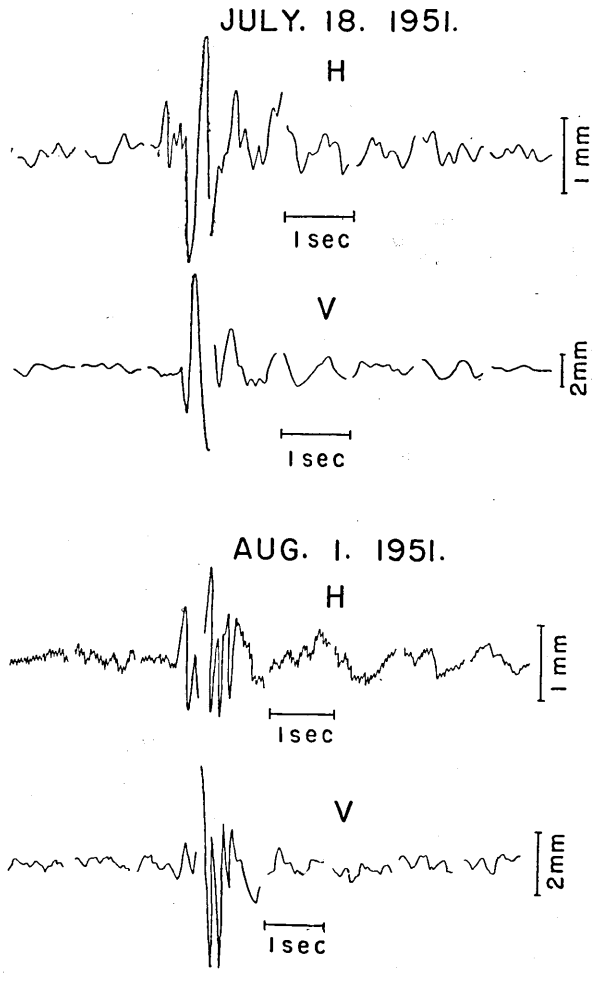

Fig. 1. Upper two records observed at the northern mill (67 m), lower at the southern mill (55 m).

servation was not sufficient.)

The acceleration of the maximum amplitude in vertical component was greater than that in horizontal. But at about 200 m distant, the values of acceleration in the two components became near, and probably at far off stations the horizontal component will be greater than the vertical. The difference of acceleration would be mainly due to that of the vibration-period as seen in Table I and Fig. 2.

To compare earth-vibrations at different places, an iron ball about 2.3 tons in weight was dropped from 7m height to the ground at the southern mill of the factory about 800 m south of the former place. The results are shown in Table II and Fig. 2. Although the energy of the falling of the mass was about 16/30 of the former case, the acceleration of the ground motions was larger than that in the former case. The 2.3 ton ball fell directly to the ground, but the 5 ton mass stroke the ground moderately for it fell to a heap of iron scraps. The writer considers the difference to be due to the condition of the ground.

The vibration-periods at the southern mill were smaller than those at the northern, so the writer thinks the ground accelerations at the two places mainly depend upon the difference in the vibration-period

of the ground. The difference will be made only at the surface layer of about 2 m thick. But at 67 m in the northern mill, accelerations were comparatively small. The small acceleration would be due to the hardness of the ground where the tromometers were set because the instruments were set near an office house and the foundation of the house was made firm.

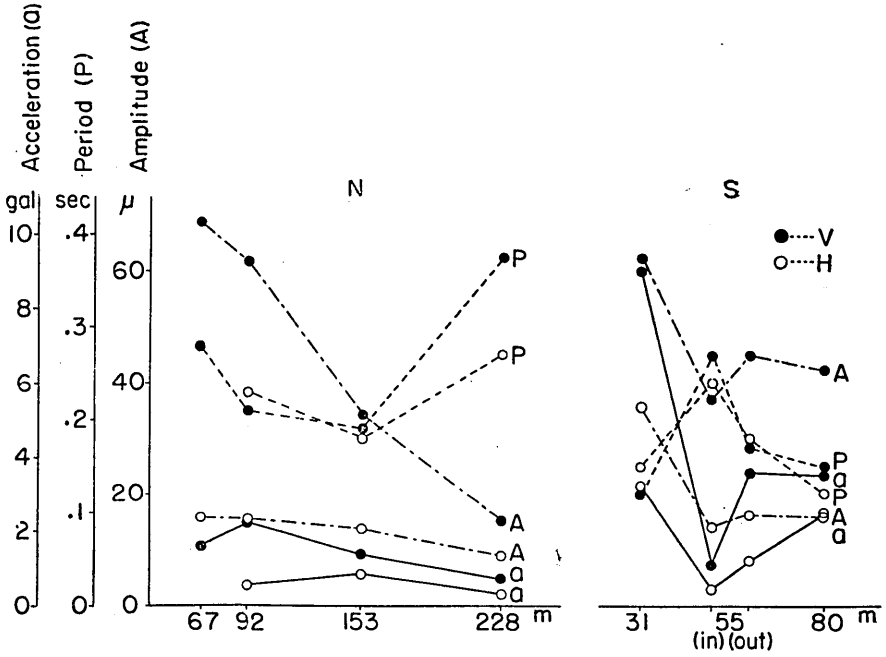

Fig. 2. N, S=Observations in the grounds of the northern or southern mill respectively.

Table I.

Distance (m)		67	92	153	228
Acceleration (gal.)	V	1.61	2.26	1.40	0.73
	H		0.54	0.89	0.32
Period (sec.)	V	0.28	0.21	0.19	0.38
	H		0.23	0.18	0.27
Amplitude (μ)	V	69.0	62.2	34.2	15.3
	H	15.9<	15.9	13.7	9.0

V: vertical component, H: horizontal component.

Table II.

Distance (m)		31	55(in)	55(out)	80
Acceleration (gal.)	V	9.04	1.13	3.58	3.52
	H	3.23	0.49	1.20	2.41
Period (sec.)	V	0.12	0.27	0.17	0.15
	H	0.15	0.24	0.18	0.12
Amplitude (μ)	V	62.3	37.3	44.9<	42.3
	H	35.5	14.0	16.4	16.2

in: in the workshop, out: out of the workshop

The effect of the superficial ground to the acceleration of the ground motion may be ascertained by the following relation. In the site of the southern mill the tromometers were set in and out of a workshop house to compare the ground motions at two places. The third and the fourth columns of table II shows the results obtained. In the workshop, the accelerations were smaller and the vibration-periods longer than those out of the shop. The foundation of the shop was constructed with concrete base buried about 2 m deep. So the shop may be considered as a heavy mass imbedded on the soft ground, and the amplitudes will become small on the concrete mass.

Although the above results are simple, the investigation of vibrations on the soft ground will be an interesting problem, and the writer is making further study of it.

Lastly the writer express his thanks to Mr. R. Ikegami, Mr. J. Moroga and Mr. H. Yoshioka for their help in the observations, and to Miss M. Kotaka for her assitance in preparing this paper. The cost of this study was defrayed from the Grant in Aid for Developmental Scientific Research of. the Department of Education.

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7. 軟弱地盤の上に落された物體によつて起された土地の振動

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東京都江東區南砂町の軟弱地盤といわれる土地に重い物體が落された時の土地の振動を微動計によつて記錄し，距離・振動の振幅及び加速度の關係を調べた．互に 800 m 離れた 2 個所で觀測して比較し，又基礎の硬い工作場の內と外とに微動計を据えて比較した．その結果，地表から 2 m 位の地質の差が振動周期とそれに關連して振動加速度に影響すると考えた．