24. Vibration Tests of Defective Buildings.

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The principal purpose of this paper is to show the actual examples of buildings which have certain defects from the view point of earthquake-proof construction. As is well known, the fundamentals of satisfactory earthquake-proof design are symmetry of plan, mass and rigidity. If these conditions are not satisfied the house will not vibrate as a unit and the failure at the connexion of the parts of different characters will be the result. A defective footing is of course dangerous. The houses which are described in this paper were tested under a forced vibration which was caused by a vibrator. From the results of this test the behavior of the houses during an earthquake has been made clear. A brief note of the results will be given in the following.

(1) A reinforced concrete building of three stories which was reported[1] to be considerably damaged in the Kwanto earthquake of 1923, was tested (Fig. 1). The vibrator and the seismographs were installed in the places as

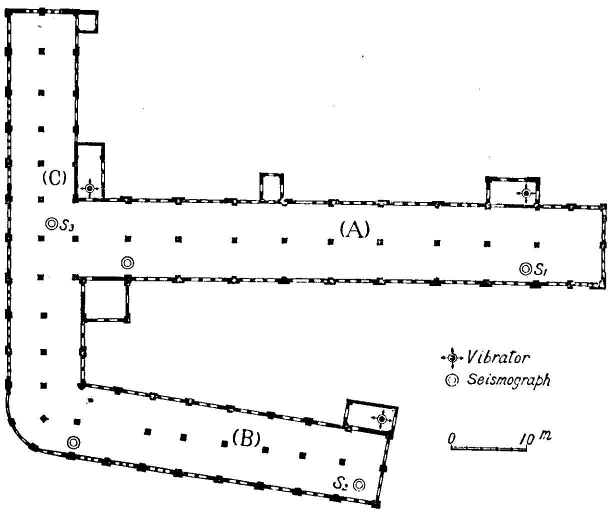


Fig. 1.

1) Yosiro NAGATA, *Report Earthq. Inv. Comm.*, II, No 100 C, 1926.

shown in this figure. In the transverse direction, three parts of the building (A), (B) and (C) showed a resonance with different periods, that is, 0.41 sec. at S_1, 0.39 sec. at S_2 and 0.26 sec. at S_3. In the longitudinal direction, 0.16 sec., 0.30 sec. and 0.22 sec, were the resonance-periods on these points respectively. Thus, we see that the three parts of this building have periods different from each other. The deflections in the transverse and the longitudinal diretions are shown in Fig. 2. A noteworthy fact is that the deflection of Part-(B) is particularly large as compared with those of (A) and (C), especially in the transverse direction. The curve in this case is similar to that of the column hinged at the base. This indicates that some of the columns in part-(B) are defective. Actually, the failure of the columns near the end of (B) was found after the 1923 earthquake and these damaged columns were repaired, but this repair-work is not effective at present. For these columns further improvements are being made so as to increase the area of the cross-section and joint the separate footings so as to form of a continuous footing.

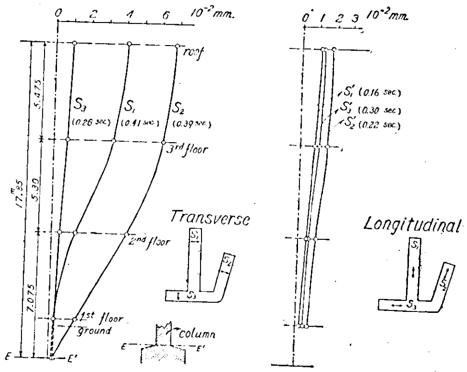


Fig. 2. Deflection.

(2) A reinforced two-storeyed building (Fig. 3) which was burnt by fire in 1923 and 1945 was tested. Although the columns and walls on the second floor have been temporarily repaired for the present, they are not strong enough to resist a violent shock, because large crack are still seen in them. Moreover, no repair-work has been done on the first storey. The plan of this building and the stiffness is not symmetrical; perhaps less stiffer in the middle and strongest near the water tank. The building will rotate about an axis lying near this strongest

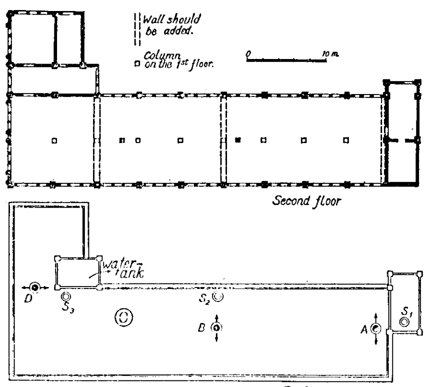


Fig. 3.

point. This motion is actually seen by the vibration test as shown in Fig. 4. The period in this case was 0.20 sec. Curves-1,-2,-3 and -4 show the rotation determined by the simultaneous observations at S_1, S_2 and S_3.

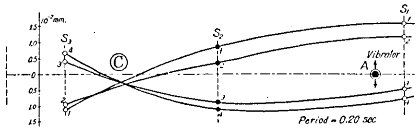


Fig. 4.

When this building was shaken at B by the vibrator in the transverse direction, a resonance occurred with a period of 0.37 sec. The largest amplitude was naturelly in the middle of the roof of the building. As in the previous example, the deflection curves, in Fig. 5 was similar to that of the column with

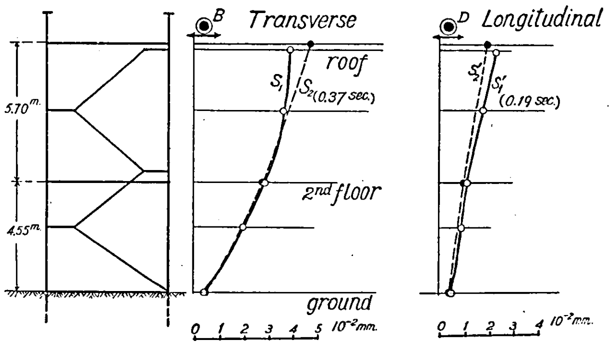


Fig. 5. Deflections.

a hinged end. This gives a warning against the danger of collapsing in case of an earthquake. All columns and walls must be repaired and at least three partition-walls of reinforced concrete must be added in the positions as shown in Fig. 3.

In the longitudinal direction, the natural period was 0.19 sec. From the longitudinal deflections alone, the failure of the column is hardly to be detected.

(3) The third example is a wooden building of two stories which was recently completed. The plan of this building (Fig. 6) is rectangular, being divided into two parts, (A) and (B), by a reinforced concrete wall. In (A) no partition wall existed, whereas in (B) there were several partitions and the sizes of the room were small. Hence there must be some unbalance of stiffness betweed (A) and (B).

When the building was shaken in a direction perpendicualr to the concrete wall, all parts of the second floor moved as a unit. This proves that the wall is effective for the vibration normal to the wall. The response curve is shown

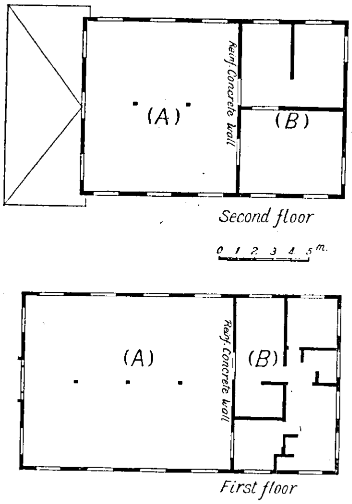
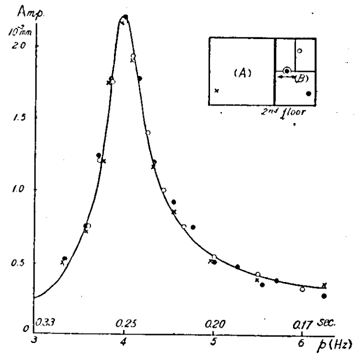


Fig. 6.



Fig, 7. Response curve,
p = frequency,
Amp. = amplitude.

in Fig. 7. However, in the direction parallel to the wall, (A) and (B) vibrated with periods different from each other. The response curves obtained (Fig. 8,

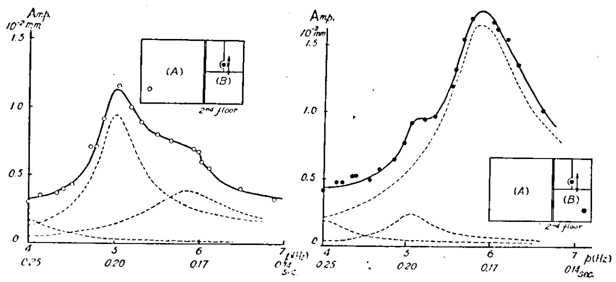


Fig. 8. Response curves of (A) (left) and (B) (right).

left for (A), right for (B)) are not simple in this case, because of the relative motion of (A) and (B). This will cause the failure of the parts near the concrete wall when the shock becomes large. Further, the motion of (A) is restricted on one side by this wall and the amplitude is always larger at the other end than near the wall like a cantilever. A comparison showed that on the second floor the ratio of the amplitudes at 8 m. and 1 m. from the wall was 4.0 : 1. Fig. 9 shows the resonance curve at 1 m. In this case, the vibrator was installed in (A). Thus, the left end of this building vibrates with a larger amplitude than any other parts, and the end must be supported obliquely by stays extending from the roof down to the ground.

Further, the ends of the beams of (A) and (B) should be jointed rigidly, for example, by means of metal-ties and bolts.

The study is continued also on structures outside of building through the Fund for the Science Research of the Ministry of Education for the year 1950.

I wish to express my sincere thanks to Prof. T. Naito of the Waseda University for his kind advice and guidance.

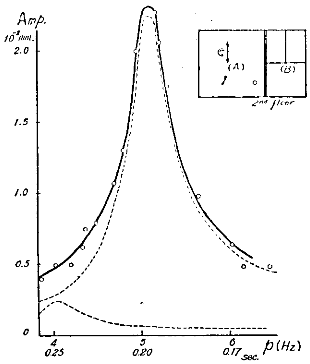


Fig. 9. Response curve of (A).

24. 非健全家屋の振動試驗

地震研究所　那須信治

火災のため相當ひどく破損したコンクリート建物及び新築の木造ではあるが，構造上缺點があると思われる建物の振動測定結果から補强對策の一例を述べた.