Vibrations of a Railway Bridge Pier.

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A preliminary series of the measurement of the vibrations of railway bridge piers was carried on in 1901, the first report on this subject having been given in the *Publications of the Earthquake Investigation Committee*, No. 12. I have continued these measurements with my horizontal tremor recorder, in which the two horizontal component pointers had each a magnification of 10 to 50 times, the registration being made in ink on white paper driven by rollers. The diagrams obtained were, as shown in Pl. XXXIX, very good.

Tone-gawa Bridge, near Toride Station, Nippon Railway. This single-track (3′ 6″ gauge) bridge consists of eight 200′ Double Warren trusses and twenty-two 60′ plate girders. On Aug. 27, 1904, I have made a series of measurements of the vibrations of the pier between the 7th and 9th 200′ trusses,* (counted from the Tokyo end of the bridge). The pier experimented on was built of brick and had a total height of 94′.2, of which 29′.35 was above the river bed and had a thickness of 10′, while the remaining 64′.86 formed the well and had a thickness of 12′; the depth of water being about 10′. † The tremor recorder was set up on the

* This is one of the piers experimented on in 1901.

† The elevation and plan of the pier is given in the *Publications*, No. 12.

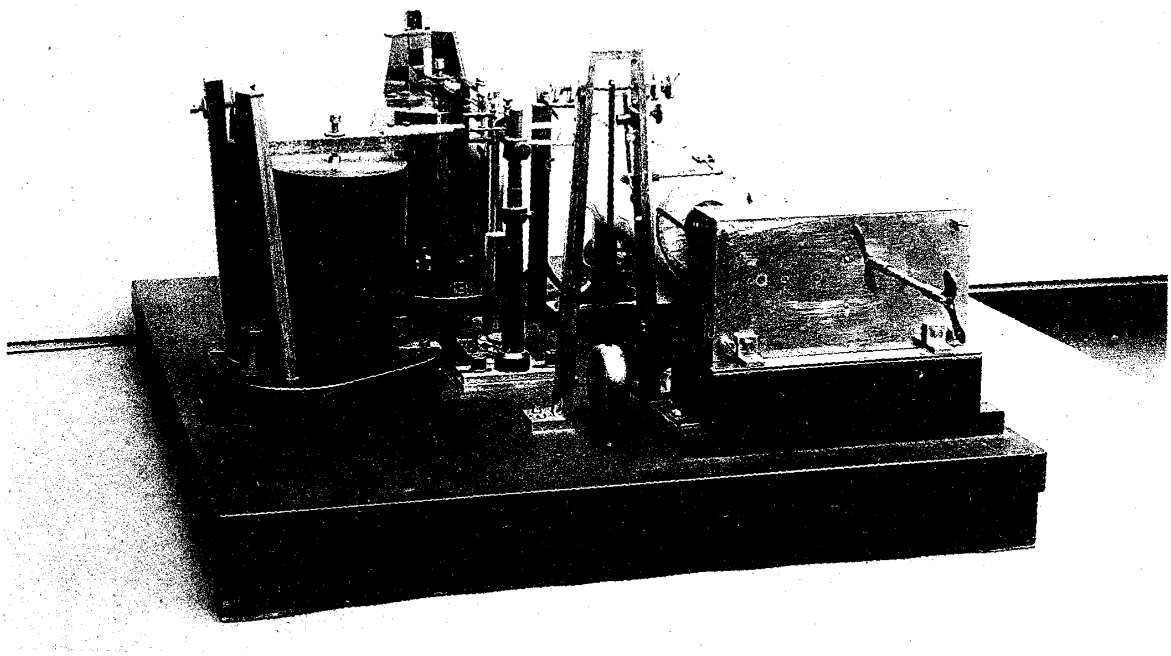
top of the pier; Pl. XXXVIII being a picture of the instrument. Pl. XXXIX is one of the diagrams obtained, and magnifies 30 times both the longitudinal and transverse vibrations; these two latter being respectively the movements of the pier perpendicular and parallel to its face or plane. The motion was caused, in the case under consideration, by an up train consisting of a locomotive and 44 goods wagons at a slow speed. As will be seen from Pl. XXXIX, the greatest transverse vibrations occurred not at the moment of the transit of the locomotive, but when the end car of the train was just passing over the pier; there being a series of maximum movements, which corresponded to the successive piers, on account of the transmission of the transverse motion of the differrent piers through the means of the girders. Again, the longitudinal vibration was by no means small, as ought to be. In fact, as shown in my previous paper, a pier which rises from soft and muddy river bed does not vibrate with its base, that is to say, junction with the well as the centre or fixed point; the real position of the latter being a considerable distance below the ground surface. In our case, the centre of vibration is 40′ or 50′ deep; the pier (and the well) with the girders thus forming virtually a tall brick column, 60′ or 70′ in height, with heavy top load. Hence it is natural that the pier should vibrate parallel to its face as well as at right angles to the latter. The elements of motion were as follows:—

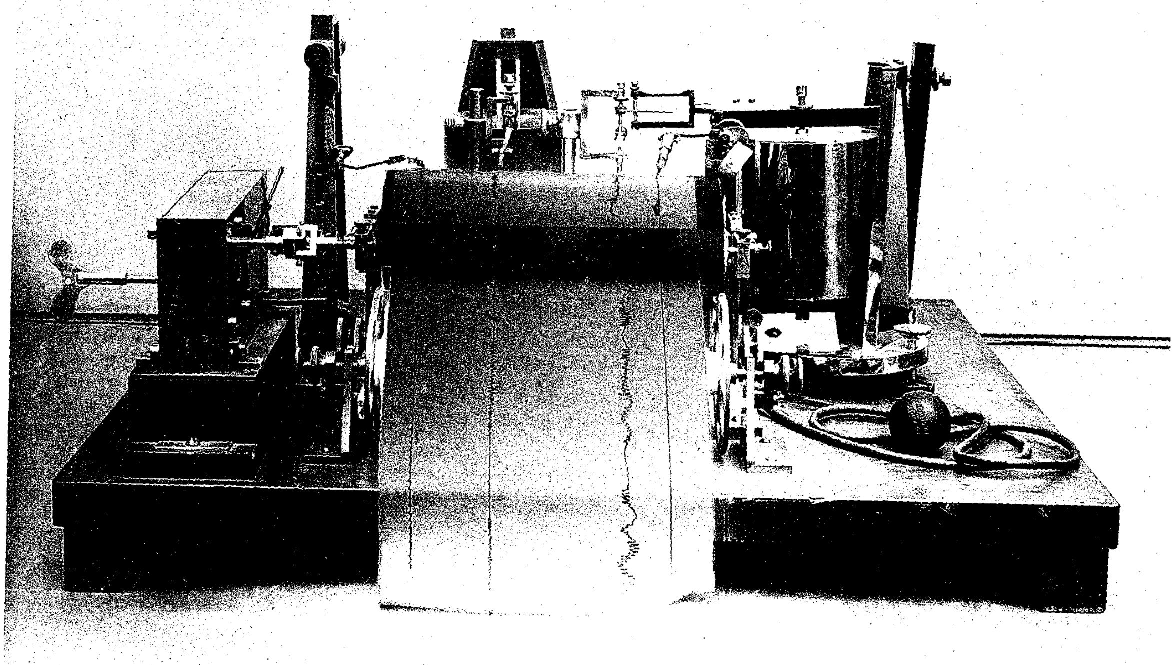
Transverse Vibration.

{Complete Period=0.39 sec., max. motion=0.63 mm;
{ ,, =0.18 ,, , ,, =0.08 ,,

Longitudinal Vibration.

Complete Period=0.22 sec., max. motion=0.33 mm, Horizontal Vibration Recorder.

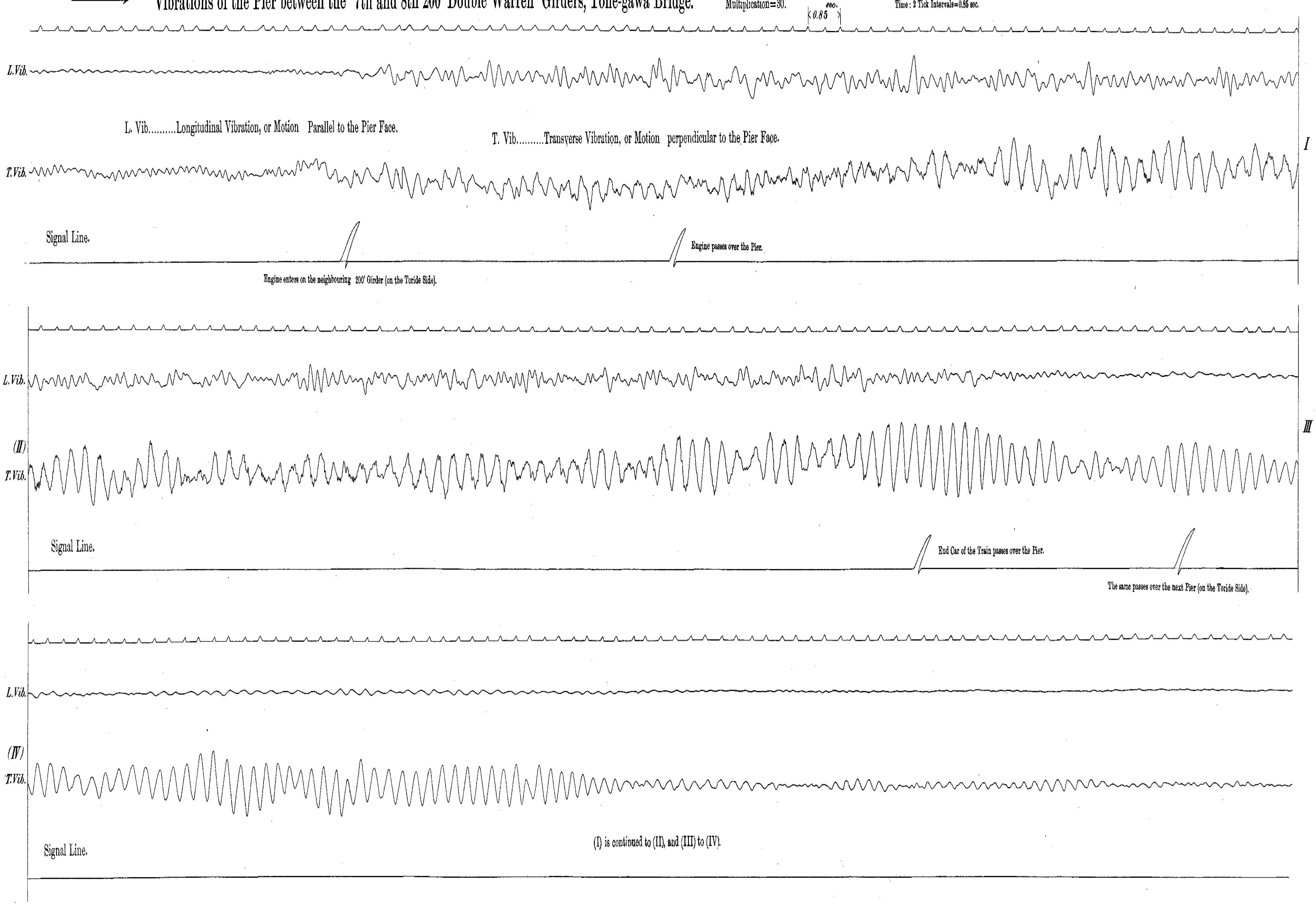




PL. XXXIX.

Vibrations of the Pier between the 7th and 8th 200′ Double Warren Girders, Tone-gawa Bridge.

Multiplication=30. Time: 2 Tick Intervals=0.85 sec.



there being also some traces of slow movements of period of 0.7 sec., due probably to the effect of the lateral vibration of the 200′ girders. Towards the end, the movements became small and regular, there being the following two sets of motion:—

$$\begin{cases} \text{Complete Period} = 0.37 \text{ sec.} \\ \quad\quad ,, \quad\quad = 0.24 \;\; ,, . \end{cases}$$

Thus in this case the amplitude of the longitudinal vibration was half of that of the transverse vibration. But as the periods of the principal movements in these two components were 0.39 and 0.22 sec. respectively, it comes out that the acceleration of the longitudinal vibration was nearly double that of the transverse. If we further take into consideration the fact that the breadth of the pier was not less than twice the thickness, the great importance of the longitudinal vibration in its relation to the strength of the pier will be readily recognised.

A full report on the measurement of the vibrations of the different brick and iron piers will be given in a future number of the *Publications.*