A NOTE ON EARTH VIBRATIONS

BY

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Professor Paul's Note on the transmission of vibrations through the ground by railway trains reminds me of some rough experiments, of a somewhat similar kind to those described by him, which I made in New Zealand in 1874, when in change of the British Government Expedition to that colony for observing the Transit of Venus. My experiments were of a very simple kind.

I had chosen a site for my observatory near the Burnham railway station on the Canterbury plain, about 400 yards from the line, which ran past it in a southwesterly direction; and I required to ascertain what depth of excavation would be necessary in order that the instrument-piers should not be affected by the surface-tremors caused by passing trains. For this purpose, I merely dug a trench about eight feet long and three feet wide, in a north and south direction, on that side of the proposed site which was nearest to the railway, and arranged with the government that a heavy goods-train drawn by two engines should be at Burnham about the middle of the day on which the experiments were to be made. The testing process was then as follows. The trench was first excavated to a depth of two feet, and a tray of mercury placed on the bottom, in such a position that the sun's image in the mercury could be viewed in the telescope of a portable transit-instrument mounted roughly at the south end of the trench. The train was then driven slowly and quickly to and fro on the

line, and the sun's image carefully watched in order to detect any tremors on the surface of the mercury. I have no notes of the results with me, but I can recollect that at the first experiment the disturbance was very considerable, being least when the train moved slowly, and greatest at the highest speed, about 30 miles per hour. The test was then repeated, at depths of 2½, 3, and 3½ feet, with the result that the tremors diminished with the depth, and that at the last-named depth not the slightest disturbance could be detected under any conditions of the train's motion. The subsoil, from about a foot below the surface, was a coarse pebbly gravel. The ground between the railway and the observation-point was a flat grass plain, with no intervening cuttings. I think the power used was about 45, and I was sufficiently satisfied with the results to conclude that isolation of the instrument-piers to a depth of four feet would serve for complete protection from the effects of trains. Subsequent experience confirmed this opinion.

As you are interested in the subject of earth-tremors, I may further mention a curious fact, perhaps not very generally known, which came under notice at the Greenwich Observatory several years ago. The observers found that from time to time, at considerable intervals, there would be an evening when the usual observations for determining the collimation-error of the transit-circle by means of reflexion in a tray of mercury could not be taken, on account of the constant trembling of the surface of the mercury, which on such occasions would continue until long past midnight.

For some time the staff were greatly puzzled by this phenomenon, until at length, a series of the dates of its occurrence having been obtained and examined, it was found that these dates coincided with the public and bank holidays. On those days, crowds of the poorer classes of London flock for amusement to Greenwich Park, and a favourite pastime with the young people, often prolonged until after nightfall, is to clamber to the top of the steep slopes of the hill on which the Observatory stands, in fact, to the paling of the enclosure, and then, joining hands in twos or threes, to bolt precipitately to the bottom, where, as may be imagined, they usually arrive

"all in a heap." Hundreds join in this sport on fine evenings, and the result, as shown by the behaviour of the mercury, is to set the whole of Flamsteed Hill in a tremor, which does not subside until early the next morning, many hours after the people have left.

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