ABOUT THE PROTECTION OF STRUCTURES FROM THE EXISTENCE OF RADIATING ELASTIC WAVES IN THE SOIL

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Fig. 1. General view of location of the trench the source of vibration, and the apparatus for measuring the vibrations

One of the measures sometimes adopted for the protection of structures from vibration is the digging of trenches, sheet piling, or some other barriers, are set up between the structure and the source of vibration. Sometimes these methods are effective, but often they are ineffective; as in their construction the necessary conditions for effectively screening the structure from the above waves are not carried out properly.

Experimental research into the required field conditions, which would satisfy the demands for an effective screen, was for the first time carried out by the above institute in 1933 (Experiments carried out by D. D. Barkan & A. I. Michaltchuk) through an investigation of the distribution of oscillation from a stabilized source of vibration (a foundation with a vibrating machine) in a porous brown loam, permeated with water. In these experiments the sheet piling was investigated. At first it was driven to a depth of two meters at the foundation which was the source of oscillation, and afterwards at the foundation which was the receiver of the oscillation. The experiment was carried on with vibration frequencies of 540 and 900 vibrations per minute. In accordance with the theory of defraction of waves, it was found that a row of special driven at the source did not show any influence in the direction of diminishing the amplitudes of oscillation of the receiver. On the other hand when the row of piles was driven at the receiver, the amplitudes of vibration of the latter were considerably diminished.

From the theory of wave defraction it follows, that not in all relations between length of the screen and the length of the radiating waves, is it possible for shadows to form beyond the screen; of the measurements of the screen (for instance its depth) is small relative to the length of the wave, then the formation of shadows could possibly, not form.

An observation into this circumstance was carried out during an investigation into the radiation of waves in loess, from the vibration of an experimental foundation, (Experiments carried out by D. D. Barkan, J. N. Smolikov and P. A. Saitchev) subjected to experiment was a trench having a depth up to 4 meters, and a length of from 8 to 11 meters (Fig. 1), and also a row of sheet piling.

The foundation which was the source of oscillation experienced only vertical oscillation with a constant amplitude. The measurements of the oscillation of the soil were carried out with the aid of a vertical seismograph.

Experiments proved that with a wave radiation frequency of less than 900 periods a minute, and with the depth of the trench less than 4 meters the distribution of the amplitudes along the surface of the soil in the direction from the source of vibration across the trench, perpendicular to it, is regular and the trench does not show any observable distortion. In a trench depth of 4 meters, and the frequency of oscillation of 900 a minute a distortion is brought about in the distribution of amplitudes along the indicated profile: the amplitudes beyond the trench suddenly diminishing (Fig. 2 and 3).

As well as that, an investigation was carried out into the distribution of amplitudes along the depth of the trench on both sides of it, i.e. the one adjacent to and the other opposite from the source of oscillation. From which it was noticed, (Fig. 4) that with the radiation of waves having an oscillation frequency of less than 900 a minute, the amplitudes on the side opposite the source diminished in accordance with the same law as those on the side near to the source.

On the other hand, with the radiation of the waves reaching a oscillation frequency of 900 or more the amplitudes of oscillation on the side of the trench opposite to the source, remained constant almost throughout the whole depth, and even increased somewhat on nearing the bottom of the trench.

Such a distortion of the distribution of the amplitudes is possible only in case of defraction of the radiating waves.

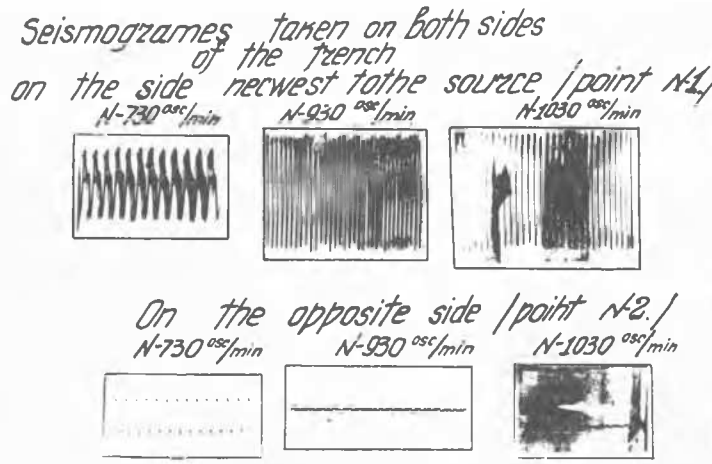

FIG. 2

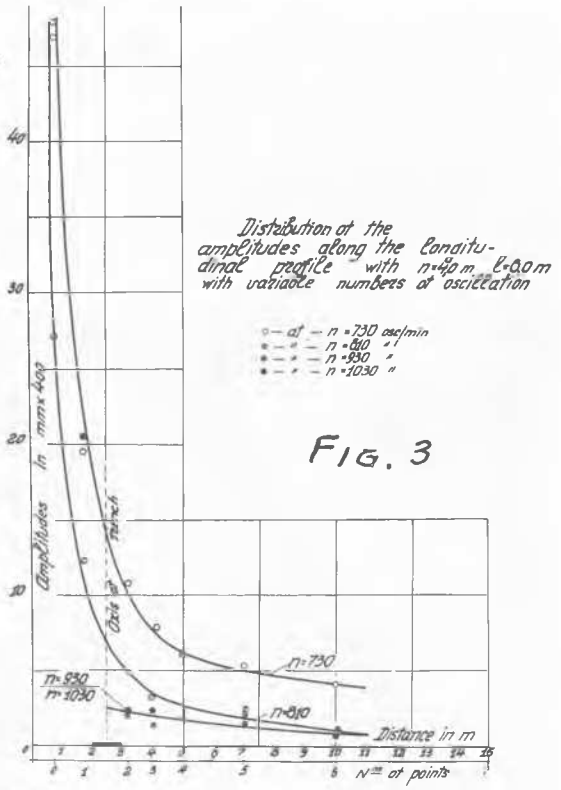

FIG. 3

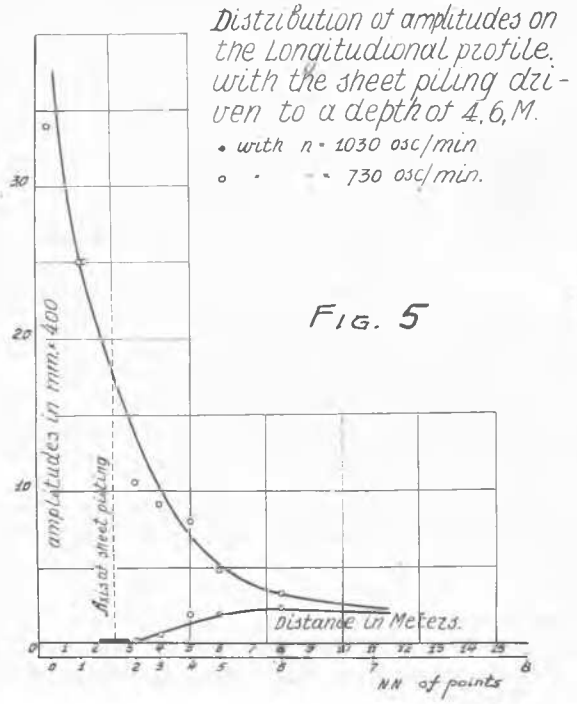

FIG. 5

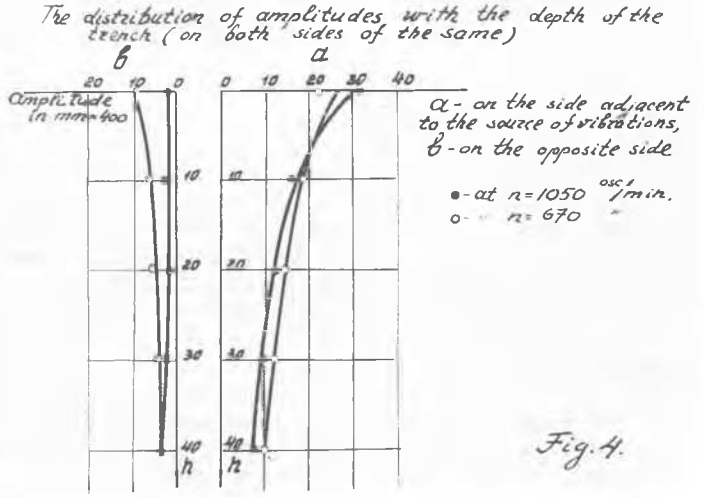

Fig. 4.

Similar results in the distribution of the amplitudes along the surface were also obtained for a straight line row of sheet piling barrier (Fig. 5).

The experiments, then confirmed, that the screening of oscillations in the given dimensions of the screen is not possible with all periodic laws, and consequently also lengths, of radiating waves.

The screening of waves was noticed, only for periods less than 60/90 = 0.066 sec. for velocities of surface waves in loess around 180 m/sec. (This value of velocity is calculated from the modulus of elasticity for loess, equal to 1.200 kg/cm^2 and known for Poisson's coefficient equal to 0.3. Sig. D. Barkan) The greatest length of the screened waves was obtained at about 12 m, so that the least ratio of the depth of the screen (of either trench or piles) to the length of the waves being screened, are equal to about 0.33 meters.

From these experiments it follows, that the greater the periods of radiating waves, the larger should be the dimensions (especially the depth) of the screen, for the purpose of screening the waves.

For the screening of oscillation from low frequency machines (such as diesel engines, compressors and steam engines) the minimum dimensions of the screen in soils of medium strength must reach 20-30 and more meters, i.e. practically impossible of attainment. For the screening of high frequency machines the dimensions of the screen could be chosen considerably less, in practically attainable dimensions. And so the experiments allowed of an important conclusion to be drawn, explaining in particular the unsuccessfulness of adopting a practical means of screening and protecting structures:

Oscillations radiating from low frequency machines are practically impossible to screen.