

Wind is swaying th Earth

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The upper layer of the earth's crust may be investigated using high-rise buildings' vibrations under the wind pressure. This simple and economical method of seismic survey was developed by the specialists of the Arkhangelsk Institute of Ecological Problems of the North (Ural Branch of the Russian Academy of Sciences) and the Schmidt Institute of Physics of the Earth (Russian Academy of Sciences) under the guidance of F. N. Yudakhin, Corresponding Member of the Russian Academy of Sciences. The method was born from revision of the active snap location in the earth's crust in the Arkhangelsk Region, at the Northern Dvina mouth.

Winds are rather strong in the surface atmospheric layers. Internal whirlwinds occur, creating wind surges. Wind impulses cause vibrations to the objects protruding from the relief for 10 meters and more, these vibrations, for their part, being transmitted to the earth's crust. A Russian scientist B.B. Golitsyn considered possibilities of this effect back at the beginning of the last century. However, field observation did not provide distinct results at that time due to equipment imperfection.

Contemporary experiment equipment, including digital recording and methods of weak signal extraction allow to solve such tasks and to use results for deep sounding of the earth's crust.

Protruding elements of the relief may be both natural (mountain peaks, rock pillars) and artificial ones (towers, hoisting cranes, high-rise buildings). Their vibrations under the wind are described in a well-known task about vibrations of a rod with fixed end. In reality, the object is never rigidly fixed and it transmits vibrations via its foundation

to geological environment. Thus, shuddering under blasts, any sky-scraper or hoisting crane turn into a peculiar seismic source emitting its own signals. Such sources are much more convenient than vibrating oscillators, which are commonly used for the earth's crust survey.

The first advantage is that constructions more than 10 meters high irradiate low-frequency seismic signals of 5 Hz and below, that is within the frequency band of deep seismic sounding intended for research of the earth's crust and upper mantle. Normally low-frequency signals are obtained with the help of explosions in water, powerful pneumatic irradiators or hundred-ton vibrators. High-rise constructions tremble constantly, even if the wind is weak. The second important advantage of wind vibrations is that they send a signal of stable frequency. The shape of a construction is invariable, therefore the signal frequency may be impacted only by the change of construction's effective stiffness, for example, total glazing of balconies in a high-rise building. But researchers' observations of a 44-storey Moscow sky-scraper showed that these changes were insignificant. The next point important for obtaining a stable seismic signal sounding the environment – is concordance of vibration source and the soil. The seismic vibrator first “tramples down” the soil where it is installed, but a steady picture can not be expected until the seismic vibrator finally condenses the soil. A signal from the artificial construction may be used immediately, without a transition period.

Nevertheless, the method also has shortcomings. The wind is blowing at different velocity, therefore, wind vibrations have a non-constant amplitude. This inconvenience can be avoided in two ways. Additional vibration recorders can be installed in the vicinity of the source, and then readings of all devices are to be compared. Changes in vibrational amplitude of each construction can be statistically evaluated and the researchers can further work with one station.

In any case, vibrations caused by wind influence on high-rise constructions may be used for seismic survey of the earth's crust upper layer. Such scheme is simple and economical, which is important in the course of reconnaissance for selecting areas for more detailed survey, particularly in almost impassable regions. Relay towers are installed almost everywhere. Research by the Russian scientists is not only of application importance but also of fundamental significance: wind vibrations – are one more way of interaction between the planet's geospheres, atmosphere and the earth's crust.

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