

Control of the technical condition of buildings and structures on permafrost soils by the changes in the frequencies of natural vibrations (according to seismic monitoring of a pile-type building – the Palace of culture of Norilsk)

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Abstract The relationship between temperature fluctuations and changes in natural frequencies of a pile-type engineering structure located on permafrost soils is investigated in connection with the development of methods for monitoring the technical condition of similar structures. The object of the study is the Palace of Culture of the polar branch of PJSC MMC Norilsk Nickel, located in Norilsk, where in recent years the thawing of the soils has a potential threat to the stability of engineering structures. The basic values of the frequencies of natural oscillations of the building were determined in August 2021 by the method of coherent reconstruction of the fields of standing waves and are 3.0, 3.7, 4.7 Hz on the short axis and 3.5 and 5.2 Hz on the long axis. The current (daily) frequency values are determined with an error of no more than 0.01 Hz from the amplitude spectra of seismic noise recordings (without active sources), which were obtained during continuous seismic monitoring from the end of August 2021 to the beginning of September 2022. From comparing the changes in the frequencies of natural oscillations with fluctuations in ambient temperature, it follows that during the year the frequencies change significantly (in winter their values are 11–12% higher than in summer), presumably due to defrosting/ freezing of the upper part of the soil. Against the background of this change, local fluctuations in frequency values were revealed due to cooling/heating of the material of the building mainly at a positive ambient temperature (frequencies increase in direct proportion to temperature within 5–7%). According to the analysis of monitoring data after the annual cycle, the natural frequencies of the building in August 2021 and 2022 are not equal (the difference is up to 1.7%), which is presumably explained by the different depth of ground defrosting in the summer. To assess the impact of this phenomenon on the technical condition of the building, it is necessary to continue monitoring, first of all, to obtain data on changes in the natural frequencies of the building in the winter of 2022–2023 during the period of complete freezing of the ground.

Keywords Seismic monitoring, monitoring of the technical condition of structures, the influence of temperature on the frequency of natural oscillations.

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