

# The method of standing waves in the study and monitoring of buildings and engineering structures of complex structures

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Buildings and structures that are under constant seismic influence (be it explosions or earthquakes) need to be investigated and constantly monitored. The possibilities of the standing wave method for the study of buildings of different designs are considered, as well as options for using the data of this method in monitoring in order to assess seismic resistance. Two variants of the development of technology for seismic monitoring of engineering structures are considered. The first one is based on the development of a finite element model and the calculation of the dynamic characteristics of the natural vibrations of the structure. Next, the object is studied by the standing wave method in order to study its real natural oscillations by the full set of natural frequencies with the construction of wave amplitude maps, wave phases, coherence, etc. Based on the comparison of theoretical and experimental data on the full set of standing waves, the calculated finite element model is adjusted. The adjusted model is the basis for calculating the seismic resistance of the structure. Examples of comparison of the calculated standing waves and the standing waves isolated by the method from the experiment are given. It is shown that in most cases the calculated eigenfrequencies differ from the actually registered ones by up to 25%, the model adjustment makes it possible to significantly approximate the theoretical and experimental eigenfrequencies. The maximum differences do not exceed 7%. The calculation of earthquake resistance of buildings based on adjusted models has greater scientific validity. Another aspect of changing the parameters of natural vibrations of buildings is the loading of its equipment and objects. An example is the library named after Lenin in Moscow. A significant change in the mass of the book depository building led to a significant change in its own oscillations. Intense multiple modes of vertical natural oscillations have arisen. Based on the results, periodic standing wave surveys of particularly important objects are proposed to correct the changing model. The second variant of the building monitoring technology is based on the creation of a network of engineering seismological monitoring sensors in the building and continuous monitoring in order to detect changes after each intense seismic impact. In this case, the processing is performed together with the data of the regional network of seismological stations. The building monitoring system includes information about the nature of the seismic impact source and its characteristics. A preliminary step to the creation of a monitoring network is a detailed examination by the standing wave method, when all the natural frequencies of the building and the nodal lines at each of the frequencies are revealed. This information allows you to design a network with a minimum number of sensors for continuous monitoring. The study of the current characteristics of natural oscillations makes it possible to identify the moments and places of disturbances that occurred during the seismic impact through changes in the full field of standing waves in the building.