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Seismic method for quick assessment of structural health

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The technology for structural testing applied for building state inspection is presented. The main goal is to detect changes in a seismic field observed on the structure and to reproduce them in computer simulation. The discussed seismic method is based on a recording of structure response for any weak external probing impact which may be of a different origin. There are natural and artificial impacts: earthquakes, explosions, specific sources, microseisms, transport, wind pulsations, sea waves and marine tides. We use low-amplitude probing seismic impact to update (or create) a simulation model of a structure to test it versus greater dynamic loads. The key feature of this method is a relatively small nonlinearity of the structure's response towards the change of an amplitude of both probing and presumed incoming signals given the frequency ranges of these signals match. In this technology detectors are placed in the specific points of a building and on its basement soils. Three applications are discussed:
i) forecast of building stability versus artificial load. The study was carried out for the case of piles being vibro-pressed in soil. This vibroimpact may be hazard to the historical building. Sledgehammer strikes served as a low-amplitude probing signal. We observed this impact using seismic sensors installed on basing soil and on the most damaged blocks of the building. Then pile-drilling signal and hammer strikes were recorded on the soil. The estimation of proposed pile-drilling impact was made using the ratio of amplitudes for different signal sources. The quick assessment result was compared with one based on the full-scheme inspection.
ii) verification of simulation model. The influence of subway vibrations was studied for a church in construction (Sretensky monastery, Moscow). It's well-known that construction stress distribution depends on parameters of the model fixation in soils. As usual model verification can be performed after completion of construction works by matching observed and calculated natural frequencies. Another possibility is to determine the parameters of model fixture in the soil with the help of probing input method at early stage of construction, for example probing impact observations on the top floors already constructed/
iii) monitoring of the construction state using low magnitude seismicity. This example is valid for the monitoring of strategic constructions in seismic regions, in particular, for hydro power station (HPS), in our case for Chirkey HPS (Caucasus). We used low-magnitude regional earthquake (magnitude m=4.8, distance $\sim$ 300 km) which was sensed at the HPS dam as weak oscillations. This probing impact used in simulation model as input signal allowed to obtain HPS dam response signals and stress space distribution in dam. Comparison of calculated and observed responses shows the good condition of the dam state and allows to detect hazard zones in dam.