Numerical simulation of the dome of an atomic reactor destruction due to the earthquakes

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One of the main dangers for people nowadays is the earthquakes. During the initiation of seismic activity, a set of elastic waves with different amplitudes and frequencies propagate from the hypocentre. Reaching the day surface, they cause vertical and horizontal movements of the ground that leads to the disruption of ground facilities. To ensure the safety of people in cities it is crucial to have technologies for precise estimation of seismic resistivity of buildings. Nowadays the mainstream is the the calculation of the natural frequencies of construction. It is believed that if the set of frequencies, in the form of a superposition of which a perturbation is representable, is far from the natural frequencies of the structure, then the seismic stability of this structure is great. Unfortunately, this method doesn't provide adequate precision.

In this work we present the other method based on the numerical solution of the elastic system of equations with destruction using grid-characteristic method on hexahedral meshes. The discrete model of destruction is used. Two different mechanisms are taking into account. When the main stress is higher than the tensile strength of material a new crack (plane) is generated with the normal along the main stress. Shear destruction is identified if deviator of stress tensor exceeds the yield stress of material. In this case the shear modulus is drastically decreased.

To illustrate this method, we simulated the influence of dynamic signal from the earthquake on the dome of an atomic reactor as full-wave 3D problem. To cover the whole calculation domain a set of 22 structured meshes was used (see Fig. 1). Characteristic diameter of this construction was 20 m, thickness of wall – 2 m, height of foundation – 2m. One shot of the earthquake was simulated (see Fig. 2). Its duration was 50 ms, wave length – much bigger than total height of construction.
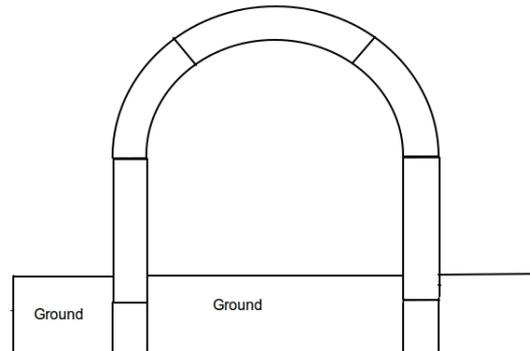
Figure 1. 2D slice of nuclear power plant model

Figure 2. Zones of destruction due to high amplitude impact