

Seismic Insulation of Public Buildings Based on PTFE

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Abstract:

Ensuring the seismic resistance of buildings and structures is a factor that must be taken into account, especially when constructing in seismically active areas. Nowadays, one of the main approaches to increasing seismic resistance is the use of various seismic insulation systems. It is not always profitable and rational to increase the seismic resistance of building structures or foundations for equipment by simply increasing strength. Increasing the strength of structures leads to an increase in their mass and, as a consequence, to an increase in inertial seismic loads.

Keywords: seismic isolation; seismically isolated buildings and structures; seismic resistance; elastomeric supports; spring supports.

Uzbekistan is located in a seismically active zone. According to official data, on the territory of the republic 359 cities and towns are located in seismically active zones. In these places, earthquakes can be from 7 to 9 points or even higher.

Since the 70-80s of the last century, seismic protection systems - seismic isolation systems (SIS) - have increasingly been used in construction. Seismic insulation systems based on rubber-metal supports (RMS) and elements with increased plastic deformation have become widespread throughout the world.

There are a number of foreign companies that develop and manufacture RMO systems of a diverse range and high quality. The leaders are FIP Industriale, Maurer Sohne, Robinson Seismic, Earthquake Protection Systems, Dynamic Isolation Systems, Scougal Rubber and others. Most of them offer combinations of rubber-metal bearings (RMM) with various types of metal damping elements. The disadvantages of such SSI are as follows:

- sensitivity of RMO to low temperatures;

- creep of rubber components of RMO;
- sensitivity of the SSI to the frequency composition of external influences due to the presence of a significant elastic component in the force characteristics, which can lead to resonant processes;
- high cost.

There is a constant search for the most effective damping elements that work in parallel with elastic ones. The principle of their operation is based on plastic deformation of special metal elements.

The task was set to develop a constructive solution for the seismic isolation mechanism and evaluate the effectiveness of its introduction into the foundation design.

It is proposed to implement the seismic isolation mechanism as follows.

During an earthquake, a foundation slab with displacement limiters and a lower layer of fluoroplastic film will follow the vibrations of the base. The top layer of fluoroplastic film interacts with the intermediate layer of fluoroplastic film, due to the low coefficient of friction in the contacts “fluoroplastic-fluoroplastic ($K_{tr} = 0.13$)”, as well as due to the inertia force of the building, the structure will be in a state of relative rest. The described device, having a friction coefficient $K_{tr} = 0.13$, is capable of reducing the intensity of seismic load by 2.5-3 points, especially at the beginning of the process, when high-frequency vibrations of the base are observed with the greatest intensity. The seismic isolating system is structurally made in the form of upper and lower supporting elements, between which an insulating layer of friction materials is placed.

To ensure that a structure displaced as a result of a seismic shock returns to its initial position of stable equilibrium, the supporting elements should be made in the form of convex and concave pyramidal planes to generate a gravitational restoring force (Fig.1)

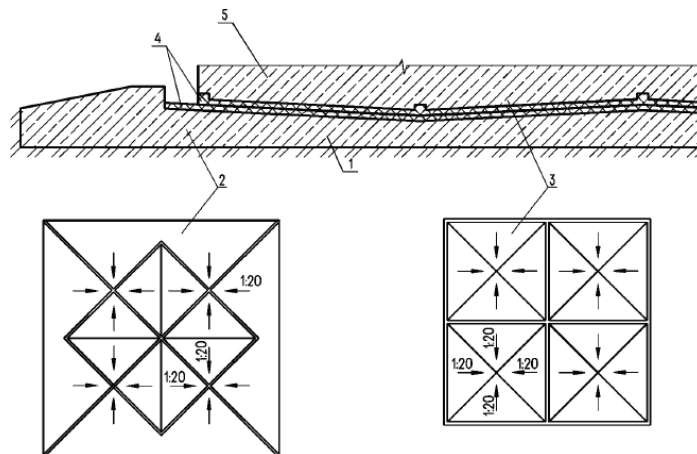
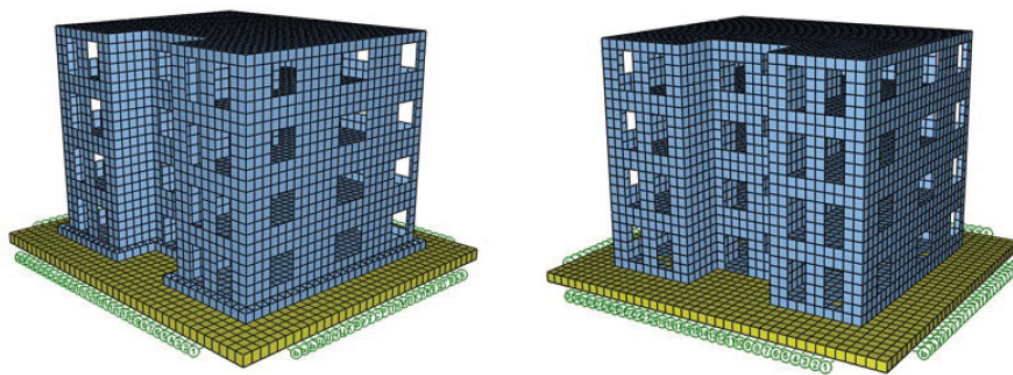


Figure 1. Diagram of the seismic isolation mechanism of the building:

1 - foundation; 2 schematic illustration of foundation slopes; 3 - schematic representation of the slopes of the bottom slab of the building; 4 – fluoroplastic plates; 5 – building.

Based on the selected design diagram of the seismic isolation mechanism, two FEMs of the building were created: one including the seismic isolation mechanism, and a similar one without it, in PC SCAD.



Seismic isolated building

Non-seismically isolated building

Figure 2. Calculation models

Comparison of the calculation results of a seismically isolated building and a building without SSI confirms the effectiveness of the seismic isolation of the building, because When installing SSI under the foundation of a building, normal stresses in vertical structural elements are reduced by an average of 80%.

As a result of the analysis of the obtained stresses, a section of the wall with the highest stresses was identified. To assess the destruction of a non-seismically isolated structure, we make the assumption that the pier with the maximum stress concentrations is destroyed. Since, under the same loads, the stresses in the elements of a seismically isolated building are several times lower, the structures of the seismically isolated building will not be subject to destruction.

Based on the results of the research presented in the article, the following can be noted: The introduction of a seismic isolation mechanism into the foundation design allows one to reduce stress in the structure and, as a result, reduces the likelihood of structure collapse, which ensures the safety of human lives and valuable equipment.

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